POWER

Volume 62 New York, November 3, 1925 *No.* 18

Fixing the Responsibility for Boiler Explosions

IN FEW, if any, of the United States of America is there any provision for an official determination of the cause and the fixing of the responsibility for a boiler explosion.

When anybody is killed, there is a coroner's inquest which sometimes develops some of the engineering particulars, but its purpose is served when it is formally determined that the victim or victims met their death through the explosion, without much reference to its cause.

When the boiler is insured, the insurance company investigates, not only to protect itself, but with the technical interest of men whose lives are devoted to the prevention of such occurrences.

When the explosion occurs in a state that has an active boiler-inspection department, the officials are usually interested enough to inquire into its cause and to see whether their inspection failed to expose dangerous conditions or whether the failure was due to the mismanagement of a sound boiler.

But few, if any, laws require or empower anyone in authority to make such an investigation, to deduce the lessons of the disaster as applied to boiler construction, inspection and operation, to determine who was responsible for the failure and to put his findings on record.

I commend to the National Board of Boiler and Pressure Vessels Inspectors the exercise by its members of all the powers with which they are now legally endowed or which they can safely assume in making thorough engineering studies of the cause and manner of all explosions occurring in their respective jurisdictions, and the interesting of themselves in the procurement of authority so to do as a function of existing departments and those to be established.

James Watt's Workshop in the Science Museum*

Historical Memorial of the Great Engineer Presented to the British Nation

By ENGR. CAPT. EDGAR C. SMITH, O.B.E. R.N.
Official Lecturer to the Science Museum, South Kensington

MANY American engineers have passed a pleasant hour among the historic engines to be seen at the Science Museum, South Kensington, where are preserved Stephenson's famous "Rocket," Arkwright's original drawing frame, Bramah's hydraulic press, the steam engine from the "Comet" and the Watt and Maudslay collections. Though its name does not declare it, the Science Museum is the great national depository of inventions and its galleries are as representative of engineering, shipping and technology as of the physical sciences. It is undoubtedly one of the principal institutions of its kind in the world, containing as it does such a great wealth of original and historic apparatus. But while this is so, on the other hand, little has been done so far to appeal to the human side of one's interest. There are but few portraits or busts and not a single statue. Of personal relics also there are few. But this side of the museum has recently been greatly enriched by the gift of the garret workshop fitted up by Watt in Heathfield Hall.

Watt, it will be recalled, removed to Heathfield Hall on the outskirts of Birmingham in 1790. The firm with which he was connected was emerging from a very difficult time, but success was assured. His purchase of the estate may indeed be taken as marking the turn of the tide, and Watt undoubtedly spent much time in laying out the gardens and grounds. The house was a fairly large and comfortable one, and it was in a garret Watt set up his bench and tools and after his retirement from active work at Soho continued to invent and construct with as much vigor as when he was the instrument maker to Glasgow University. Both Heathfield Hall and the workshop therefore have many interesting associations, and at both the Watt Centenary Celebrations in 1919 and at the World Power Conference last year attempts were made to preserve Heathfield as a memorial to the great engineer. All such attempts, however, failed and the house and grounds are doomed to pass into the hands of the builder. But through the generosity of Major J. M. Gibson Watt, the present head of the family, the contents of the room and its fittings have been presented to the nation and are now to be seen by the public in a replica of the room constructed at the Science Museum. Before removal the articles in the room were completely catalogued and photographed, and there is no question that it is still arranged very much as Watt left it. The room was opened to inspection on August 1, and it bids to rival in popular interest Stephenson's "Rocket."

The photographs reproduced here will do much more than any description to convey a correct impression of this interior of the room. Watt's lathe is to be seen under the window, his chemicals in jars on the shelves; to the left of the lathe is his desk and in the foreground his stove and the Dutch oven he occasionally cooked with. Hanging on a peg will be seen his leathern apron. The two large machines with treadles and flywheels are the sculpturing machines he spent so much time on. They were begun as early as 1808, but were not finished when he died. As time went on, Watt, no longer young, found his attic too cold in winter and too hot in summer, but nevertheless continued to work there occasionally. London contains much of interest to any engineer, but the Watt garret workshop is in many respects a unique attraction and the engineering world in general will rejoice that it has now found so suitable a home in the Science Museum.

[In Samuel Smiles' "Life of Watt" he observes, in his account of the garret life: "For days together he would confine himself here, without even descending to his meals. He had accordingly provided himself in addition to his various other tools, with sundry kitchen utensils—amongst others, with a frying-pan and Dutch oven—with which he cooked his meals.

"For it must be explained that Mrs. Watt was a thorough martinet in household affairs, and, above all things detested 'dirt' . . . She hated the sight of her husband's leather apron and soiled hands while he engaged in his garret work; so he kept himself out of her sight at such times as much as possible."

In this interesting life of Watt, written in 1865, it is also recorded that he kept all his treasures in this garret. The trunk containing the school books and papers of his son Gregory, who died at an early age, were stored here.

"His foot-lathe was fixed close to the window, fitted with all the appliances for turning in wood and metal fifty years ago; while a case of drawers fitted into a recess of the left-hand side of the room, contained a large assortment of screws, punches, cutters, taps and dies. Here were neatly arranged and stowed away many of the tools with which he worked in the early part of his life, one of the drawers being devoted to his old 'flute' tools. In other divisions were placed his compasses, dividers, scales, decimal weights, quadrant glasses and a large assortment of instrument-making tools. A ladle for melting lead and a soldering-iron were hung ready for use near the stove.

"Crucibles of metal and stone were ranged on the shelves along the opposite side of the room, which also contained a large assortment of bottles, filled with chemicals, boxes of fossils and minerals, jars, gallipots, blowpipes, retorts and the various articles used in chemical analysis. In one corner of the room was a potter's lathe. A writing desk was placed as close to the window, for the sake of the light, as the turning lathe would allow; and in the corner was the letter-copying machine, conveniently at hand."—Editor.]

*The workshop of James Watt was briefly described in *Power* in the Jan. 20, 1925, issue, page 123, at the time the decision to place the replica of the workshop in the Science Museum was announced. A picture of it taken from a drawing made by Percival Sketon which accompanied Samuel Smiles "The Garret at Heathfield," is included in this item.

Two views of James Watt's garret workshop at Heathfield

Locating Faults in Electric Elevators—Direct-Current Controllers—I

Faults That May Cause the Main Fuses to Blow and Make the Potential Switch Fail to Function Properly

By CHARLES A. ARMSTRONG

TROUBLES that may occur on elevator controller are almost limitless in their form. On the simpler types of controllers, faults when they do occur can generally be located by those with a limited electrical knowledge. In the more complicated equipment the location of the cause of faulty operation may require the services of an experienced elevator engineer. A diagram of the controller and motor connections is not necessary, but may be of material assistance in locating a fault. Some of the most successful trouble shooters have been those who paid little heed to diagrams, but depended upon a thorough knowledge of fundamental principles.

If the electrical equipment of an elevator is causing trouble, its action will give the trained trouble man a good idea where the fault is. For example, assume that the motor fails to start. The first assumption in such a case would be that the fuses are blown or the power is off the system, and this is one of the first things that should be tested for. If the controller is of a type with a potential switch, if this switch remains closed it would indicate that the circuit was alive, since the potential switch remains closed only as long as power is on the line and the emergency limits are closed.

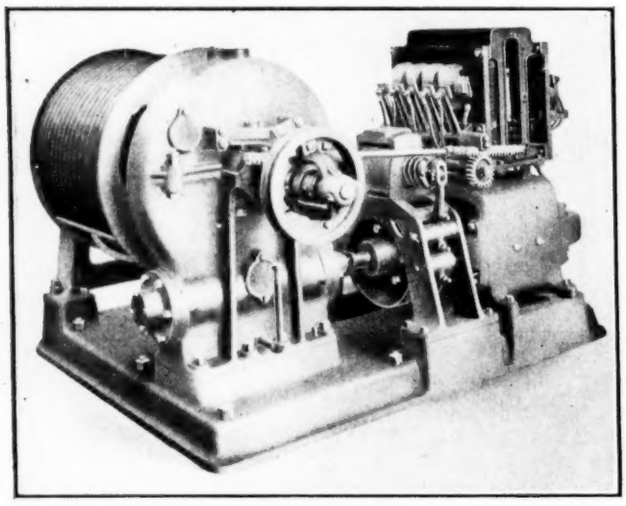


Fig. 1—Drum-type mechanically controlled elevator

Where the fuses are found blown, they should be replaced and an investigation made as to the cause. An inspection should be made to see that all contactors on the controller are in their normal off position and that they are in good operating condition. A check should be made of the brush position on the motor and to see that the brush yoke is locked in position. If the motor and controller are found in good condition, a test should be made for grounds. When making this test, not only the motor, but also all terminals on the control board, should be tested.

After testing for grounds and finding the motor and

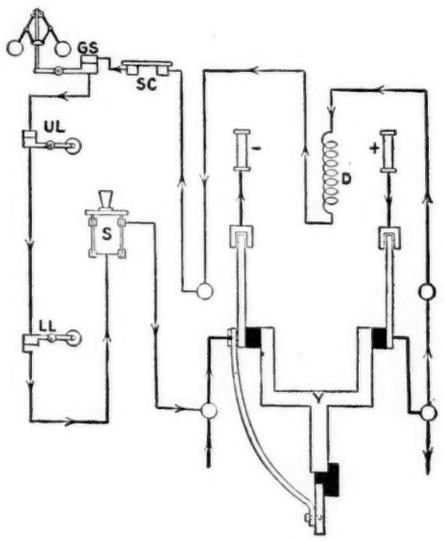


Fig. 2—Diagrams of potential-switch holding-coil circuit for medium-speed elevator

control clear, it will be advisable to test the shunt-field circuit to see that this is complete. The method of making such a test will depend on how the field winding is connected to the line. If the shunt-field winding is connected directly to the line, as in many types of controllers, then closing the line and potential switch will energize the field winding. In this case, if the field circuit is complete, an arc will be obtained at the line switch when it is opened, and the field poles will have a strong attraction for a screwdriver or a pair of pliers if placed against them when the coils are energized. When the field coils are energized and the circuit is interrupted, a high voltage is induced in the coils similar to that in a spark coil. If this circuit is interrupted too quickly, there is danger of the voltage being high enough to cause insulation failures. Therefore, if the line switch is opened, it should be done slowly so as not to interrupt the field circuit too quickly and subject the insulation on the motor to unnecessarily high voltage strains.

On some types of controllers the shunt-field winding is disconnected from the line with the rest of the motor, every time the elevator is stopped. In these cases a test of the field winding can be made by opening one side of the armature circuit, then closing the

line and potential switches and throwing the control in the car to either the up or the down position. This will allow the controller to function and energize the field coils with the armature circuit dead. Indications of the field circuit being complete are as have been previously mentioned. In making either one of these field tests, the current in the field coils can be limited by connecting a lamp in series with them, and if the circuit is complete the lamp will light.

After the foregoing tests have been made on the motor and controller and no cause of the fuses blowing

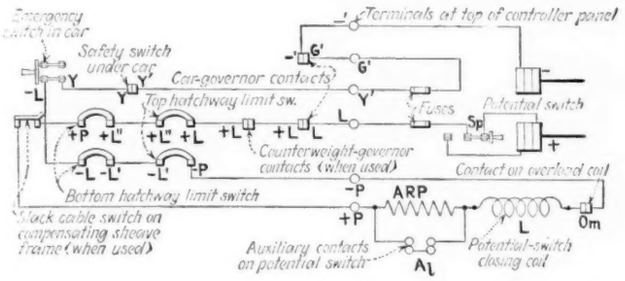


Fig. 3—Diagrams of potential-switch closing-coil circuit for high-speed traction elevator

can be found, or if a cause has been found and removed, the line and potential switches may be closed and the elevator started from the car switch. If the elevator runs all right, it should be watched for a few trips to see if anything irregular develops in the control.

Precautions To Take Before Starting the Elevator

Before starting the elevator, it will be well to block the accelerating switch open so that the starting resistance cannot be cut out. In this way a test can be made for an open-circuit in the starting resistance. With the accelerating switch blocked in the off position the motor should start, if the starting resistance and the rest of the armature circuit are completed. If the motor does not start, an investigation should be made for the cause. In some types of controller, such as those employing the counter-electromotive-force principle, the accelerating switch may not function when the starting resistance is open-circuited, depending on where the fault is in the resistance and how the magnet coil is connected. The time-limit type of controller will function and cut the resistance out whether there is an open-circuit in this resistance or not. If the starting resistance is open-circuited and part of it is cut out before the motor circuit is completed, the inrush current is likely to be high enough to blow the fuses.

Particular attention should be given to the motor when first started, to see if it functions properly. A short-circuit of a group of armature coils will prevent the motor from coming up to speed. The motor will act as though it were heavily loaded and will heat, particularly the short-circuited coils.

When starting with the accelerating switch blocked open, the motor and starting resistance should be carefully watched to see that there is nothing wrong with the former that might cause the latter to overheat. For example, a short-circuit in a group of coils in the armature would cause it to take a heavy current through the starting resistance and cause this resistance to heat excessively.

The brake should also be watched to see that it releases properly. After the motor is found to operate properly with the starting resistance in circuit, the accelerating switch should be released and the elevator brought up to full speed, all the time watching the motor and control for any irregularities.

Assume a condition where the fuses are found to be all right, but the potential switch will not remain closed. This would indicate an open in the holding-coil circuit of this switch. Various protective devices are connected in series with the coil on the potential switch. On a simple mechanically controlled machine, Fig. 1, these may consist, as in Fig. 2, of a slack-cable switch *SC*, governor switch *GS*, upper hatchway-limit switch *UL*, lower hatchway-limit switch *LL*, safety switch *S* in the car, and on some machines a final drum-shaft limit switch. The opening of any of these devices will de-energize holding coil *D* and allow the potential switch to open.

Raising the Car off the Bumpers

For example, if the car was to come down on the bumpers and the cables became slack, the potential-switch coil circuit would be opened by the slack-cable switch and also by the lower hatchway-limit switch. It would, in such a case, be necessary to take up the slack in the cable on the drum and raise the car off the lower hatchway-limit switch before the potential switch will remain closed.

After the machine has been moved by hand until the slack is taken out of the cables, the car can be raised

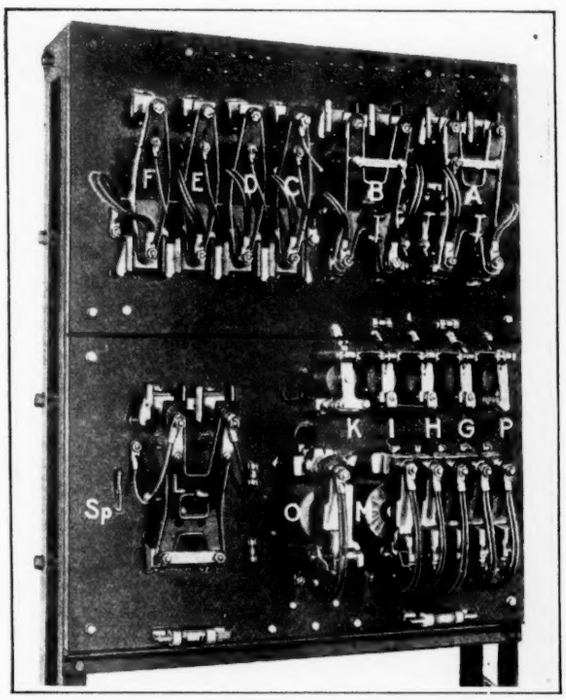


Fig. 4—Controller for high-speed traction elevator

The different switches are: *L*, potential switch; *A* and *B*, direction switches; *M*, accelerating magnet; *C*, *D*, and *F*, high-speed switches; *G* and *I*, non-reversal magnets; *H*, auxiliary-load magnet; *K*, field-resistance magnet; *O*, auxiliary brake magnet; *P*, auxiliary brake-resistange magnet; and *Sp*, knife switch in potential-switch closing-coil circuit.

by holding the potential switch closed and operating the machine from the car switch or closing the up-motion switch on the controller by hand. Care must be exercised in doing this, as a mistake may cause the counterweights to be pulled into the overhead work with disastrous results.

When the car or counterweights are bottomed and

the cables are slack on the drum, it is not advisable to try moving the machine with the motor, as there is danger of getting the cables crossed and also subjecting them to heavy strains. With the car cables slack the total weight of the drum counterweight is effective in turning the drum. If the brake is released and the machine started by the motor, before the brake can be applied again, the slack is likely to be taken out of the cables more quickly than is good for the equipment.

If an attempt is to be made to move the machine by the motor, open the brake coil circuit so that the brake cannot be released and then close the up-direction switch by hand at the control board, if the car is bottomed. In this case the brake remains applied at all times; if the motor moves the machinery, it will be very slowly and just as quickly as the power is cut out of the motor the machine will stop.

The same operation can generally be done to better advantage by using a spanner wrench on the brake-wheel coupling. Where this cannot be done, an iron bar can generally be used in the brake wheel as a lever to turn it in the desired direction. This turning can usually be done without releasing the brake. On some machines the motor shaft is extended beyond the outboard bearing, with a square end to allow the use of a wrench for moving the machine by hand.

On elevators having brakes applied by a weight on a lever, one man on the brake lever to control the motion of the car and another to turn the brake wheel by hand make for safety in taking slack out of the cables. Where the motor shaft is extended for using a wrench to move the machine by hand, it is not advisable to use a Stilson wrench, since after the machine is started it may be necessary to apply effort to the wrench in the reverse direction to control the speed of the machine. In this case there is danger of the wrench opening sufficiently to lose hold on the shaft. The manufacturers generally furnish a socket wrench to go on the end of the motor shaft, but unfortunately it is one of those things that is seldom preserved for the purpose for which it was intended and is very likely not to be available when needed.

Potential-Switch Circuit on High-Speed Elevators

On high-speed traction elevators the potential-switch circuit becomes somewhat more involved than with the drum-type machine or the slow- and medium-speed traction machines. Fig. 3 shows the potential switch circuit of an Otis type *MFL4C* controller, Fig. 4, for high-speed traction elevators. Starting from the + side of the line the circuit is through the single-pole switch S_p and a fuse on the control board. From the control board the circuit goes through contacts L on the car-governor switch, then through contact $+L$ on the counterweight governor, contact $+L''$ on the top hatchway-limit switch, contact $+P$ on the bottom hatchway-limit switch, slack-cable switch on the compensating-sheave frame at the bottom of the hatchway, then back to the control board and through coil L of the potential switch. When the switch is open, contacts A_1 are closed and resistance ARP is cut out of circuit with coil L so that when the coil is energized it can close the switch. Closing the potential switch opens contacts A_1 and cuts resistance ARP in series with coil L and reduces the current through the coil.

From the control board the circuit continues through contact O_m on the overload relay, contact $-P$ on the top hatchway-limit switch, contact $-L$ on the bottom hatchway-limit switch, one side of the emergency switch Y in the car and safety Y' under the car. The last-named switch is mounted on the car safety plank and is opened in case the governor applies the safeties and stops the car in case of overspeed. From the car safety switch, the circuit is back to the control board through a fuse and to contact G' on the car-governor switch and then back to the — main contact of the potential switch on the control board.

The opening of any of these devices in the potential-switch circuit will cause it to open and remain open as long as the auxiliary switches are open. Limit switches, located in the elevator hatchway or under the car, are subjected to dirt, grease and moisture in varying degrees, therefore their contacts should be given careful attention and kept clean, to prevent grounds and short-circuits and also to keep dirt from working into the contacts, interrupting the potential-switch coil circuit and shutting the elevator down.

Locating Cause of Potential Switch Not Remaining Closed

In case the potential switch will not remain closed, and it has been ascertained that the line is alive, all the devices in circuit with the closing coil should be carefully examined and cleaned to make sure that they are closed and making contact. This should be done after testing the fuses in the circuit to determine if they are complete. If the fault is not found in any of these auxiliary switches, then the circuit through the coil should be tested to see that it is not open. After this has been done and the coil found in good condition, it will then be a case of testing the wiring. The most likely place to find an open in the wiring is in the traveling cable from the junction box, located halfway up the hatchway, to the car.

An open-circuit in a wire of the traveling cable may be difficult to locate, since owing to the bending of the cable the wire may be open-circuited at one location of the car and at another position it may be closed, or a wire may be open and a slight movement of the cable will cause it to close. If trouble is being experienced with an intermittent open in the potential-switch circuit—that is, the potential switch will not remain closed at times and at others it will—this is a pretty safe indication that the fault is in the traveling cable and it should be renewed.

One case in mind is that where an open-circuit had been occurring in a potential-switch coil circuit at intervals ranging from a day to a week, but always before the fault could be found the circuit would close again and the elevator would operate for another period when the trouble would occur. This had been going on for about six months before it was decided to renew the traveling cable. After installation of the new cable no more trouble was experienced with the potential switch opening unexpectedly.

Testing the Traveling Cable

Where trouble of this kind is being experienced, if the car is run up the hatchway to just above the control-circuit junction box in the hatchway, the traveling cable can be pulled out on the floor. Then with the potential switch closed, begin at one end of the cable and gradually work along it and at the same time bend the cable back and forth. In this way the broken wire will probably be opened and the potential switch will open. A man should be stationed at the control board

to note when this happens. If the fault in the cable can be located, it can be repaired, but this is generally not a course to be recommended, except as a temporary measure, since the old cable is in such condition that trouble is likely to develop in a short time at another place.

The governor out of adjustment or too quick acceleration of the car may cause the governor to open its switch without setting the safeties, and open the potential switch. On some types of machines the governor switch is opened only when the safeties are set, in which case the foregoing cannot occur without setting the safeties on the car.

In Fig. 3 switch S_p has two positions. When closed to the right as in the figure, the potential switch will close when its coil circuit is energized. With switch S_p thrown to the left the connections on the controller are such that the potential switch must be closed by hand, after which it will remain closed if the coil circuit is energized. These two arrangements will cause different effects if resistance *ARP*, in series with the potential switch coil *L*, is open.

When the potential switch is open, contacts A_1, Fig. 3, are closed and short-circuit resistance *ARP* so that when switch S_p is closed to the left the potential switch will start to close. If there is an open in resistance *ARP*, then as soon as the contacts A_1 open, the circuit through the coil will be broken and the switch will open, only to close contacts A_1 and energize the closing coil, which will cause the switch to start closing again. This operation will keep up until the main line switch is opened and the power cut off the control board. It is evident that continuous opening and closing action of the potential switch would indicate that the resistance in series with the closing coil is open-circuited. Such an action of any magnet switch would indicate that the resistance in series with it is open-circuited. If the switch S_p is thrown to the left, the potential switch will remain closed only after closing by hand, and the coil circuit is energized. In this case, with resistance *ARP* open, the potential switch will not remain closed, just as when there is an open in any other part of the circuit.

The Effects of a Short-Circuit in Potential-Switch Coil

About the same effect would be obtained if part of the turns in coil *L* were short-circuited, as with an open-circuit in resistance *ARP*. When the potential switch is open, the current through its coil may be great enough to cause the switch to close. When it does close, resistance *ARP* is cut into circuit and may reduce the current to a value that will not hold the switch closed, on account of part of the turns being cut out of the coil. With an open-circuit in resistance *ARP*, when the switch closes a vicious arc should occur at contacts A_1, which would not occur with a short-circuit in the coil or if conditions in the circuit were normal. With an open-circuit in resistance *ARP* the arcing of contacts A_1 may hold over and the switch stay closed. If a short-circuit is in the coil, resistance *ARP* will get unduly hot if the switch remains closed.

It is possible for loose or poor connections to introduce resistance enough in the circuit to prevent the potential switch from closing or remaining closed after being closed. If there is a suspicion that the trouble is in the potential-switch coil and resistance, disconnecting these from the rest of the circuit and connecting them directly across the line will show how they are functioning. If improper operation is obtained under these conditions, it will be known that the fault is in the closing coil or the resistance or both.

The foregoing indicates in a general way what may cause the main fuse to blow or the potential switch to remain open. These conditions will vary widely with different types of controllers. On some equipments the potential switch coils are in series with the direction switch coils, so that the potential switch opens and closes with the direction switches. In such a connection most anything that would affect the closing of the potential switches will also affect the direction switches. The next article will deal with the troubles in the controller after power is available for operation.

What Is Increased Efficiency Worth?

Some time ago there appeared in *Power* a short item giving a simple formula for the additional investment justified by a specified reduction in coal consumption per kilowatt-hour. The following derivation of this formula may be of interest:

It is assumed that the sole effect of the increased investment (aside from the corresponding increase in fixed charges) is the reduction in fuel consumption. In short, it is assumed that the increased expenditure will necessitate no change in labor cost, reliability, life of equipment, etc.

With these assumptions, which frequently fit the practical case, the formula is:

$$I = 4.38\,\frac{WPF}{f}$$

where

I = Maximum additional investment, in dollars per installed kilowatt, justified by the anticipated coal saving W, pounds per kilowatt-hour.

F = Fuel cost (including cost of fuel handling, firing and ash handling), dollars per ton.

f = Fixed charges (interest, depreciation, taxes, etc.) per kilowatt of installed capacity on additional investment, per cent.

P = Yearly plant factor, per cent.

To break even, the additional investment I per installed kilowatt must yield at least the fixed charges $\frac{fI}{100}$ per year. Fuel costs F dollars per ton, or $\frac{F}{2{,}000}$ dollars per pound. The saving in fuel cost is then $\frac{WF}{2{,}000}$ dollars per kilowatt-hour.

The kilowatt-hours output per year per installed kilowatt will be $24 \times 365 \times \frac{P}{100} = 87.6P$, giving a corresponding yearly saving in fuel cost per installed kilowatt of $87.6P \times \frac{WF}{2{,}000} = 0.0438\,WFP$ dollars.

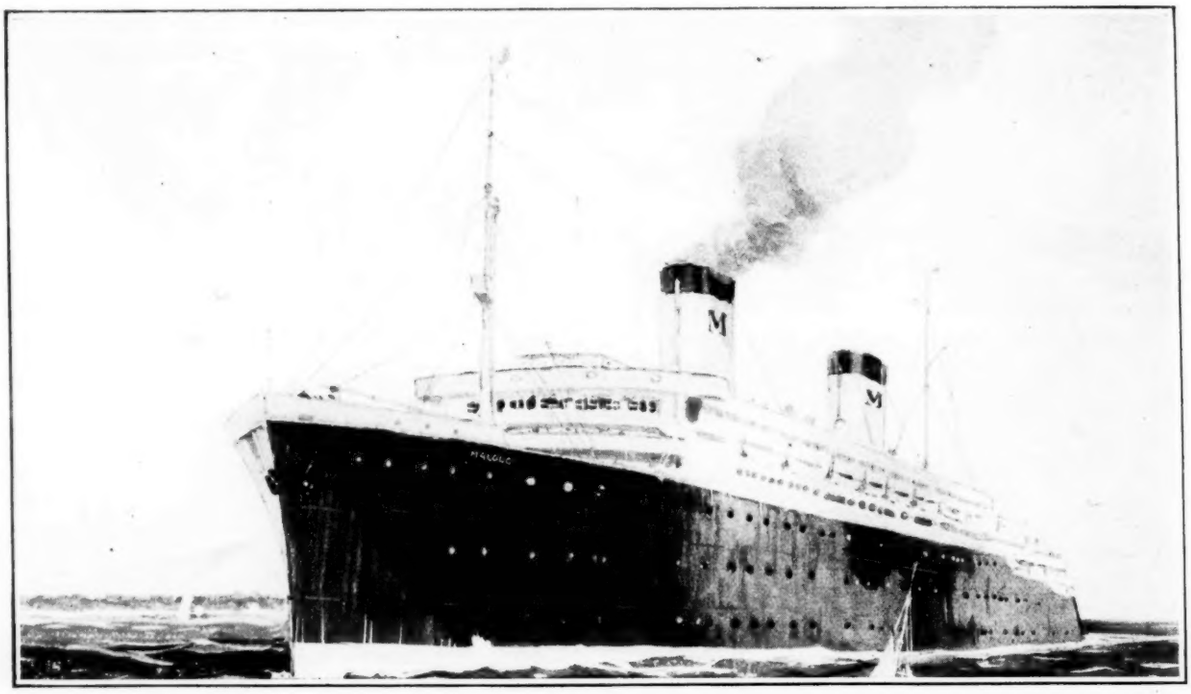
To break even, this must equal the fixed charges. Hence

$$\frac{fI}{100} = 0.0438\,WFP, \quad \text{or} \quad I = 4.38\,\frac{WFP}{f}$$

For example, with a plant factor of 40 per cent, a fuel cost of $6 per ton (including firing, handling, etc.) and fixed charges of 15 per cent, the maximum increase in investment justified by a saving of 0.1 lb. of coal per kilowatt-hour would be:

$$I = 4.38\,\frac{0.1 \times 6 \times 40}{15} = \$7 \textit{ per kilowatt.}$$

Building Turbines for America's Largest Steamer

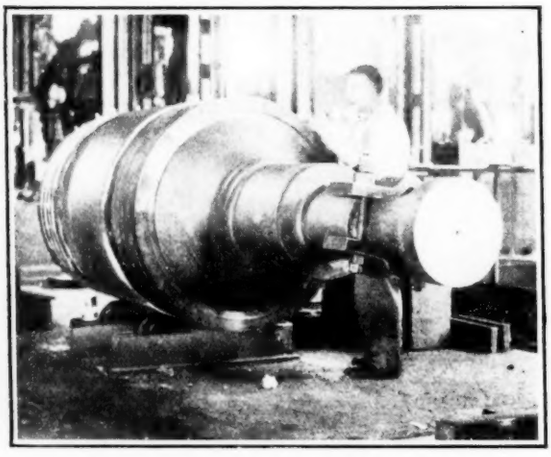


As the "Malolo" will appear when launched

The "Malolo" is a twin-screw steamer of 20,000 tons now being built at Cramp's for service between San Francisco and Honolulu. Its distinction lies in that it is the largest vessel so far built in this country.

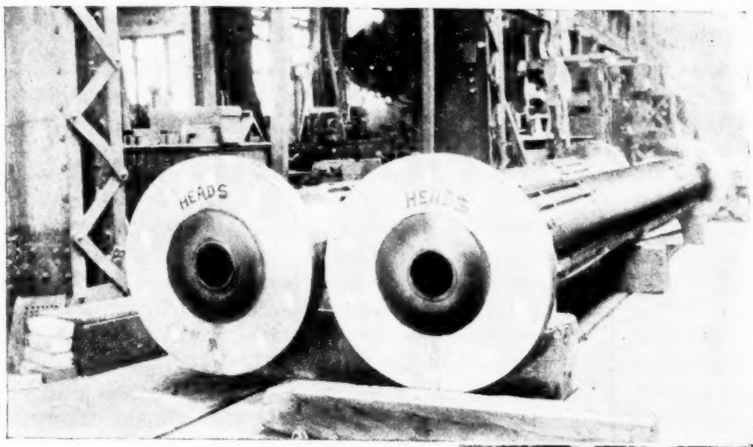
Each of the propellers will be driven by a 12,500-horsepower compound steam turbine set running at 1,500 revolutions per minute with a 12 to 1 reduction gear between the turbine and propeller shafts. These gears have a diameter of 140 inches and have a 57-inch face.

Steam will be supplied at 325 pounds pressure by a battery of water-tube boilers. Oil, owing to the availability of cheap California stocks, will be the fuel used and will be carried in the vessel's double bottom, which will hold enough for a round trip.

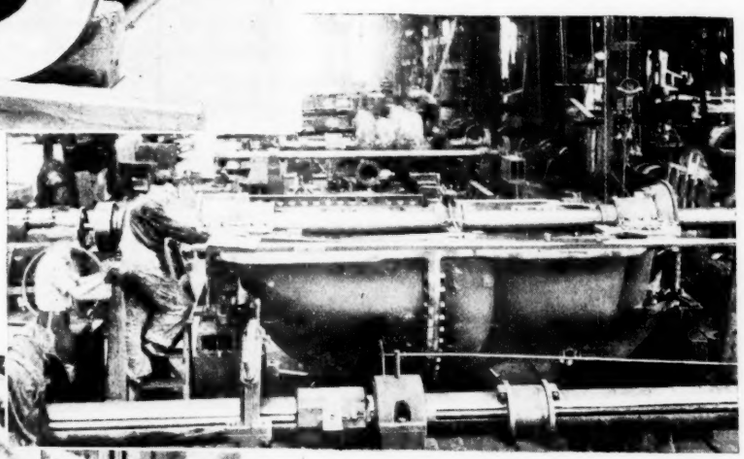


Inserting blades in the low-pressure turbine rotor

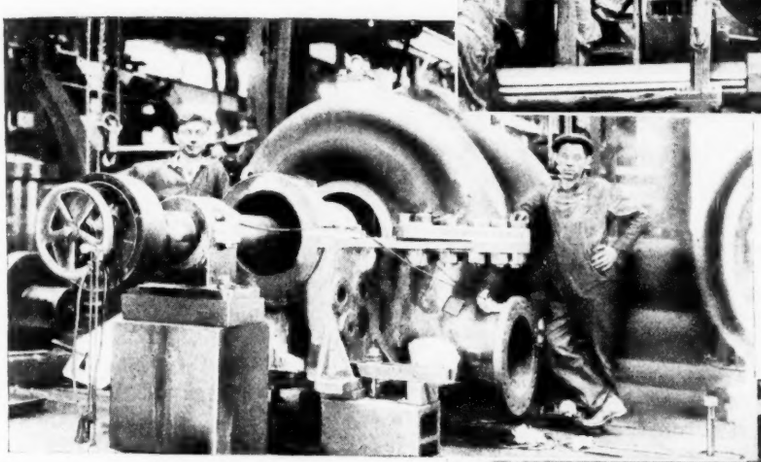
The rotors of the high-pressure turbines are steel forgings, and after they are machined and grooved the blades are inserted. Each drum is supported by bearings at both ends of the shaft.



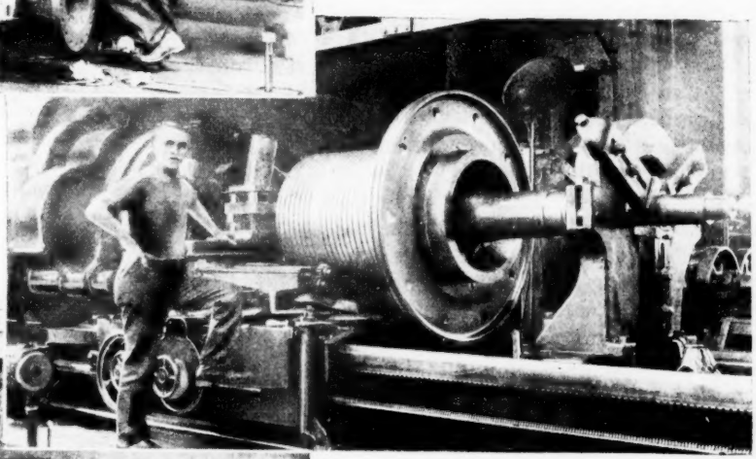
Left — Propeller shafts connecting turbines to the propellers



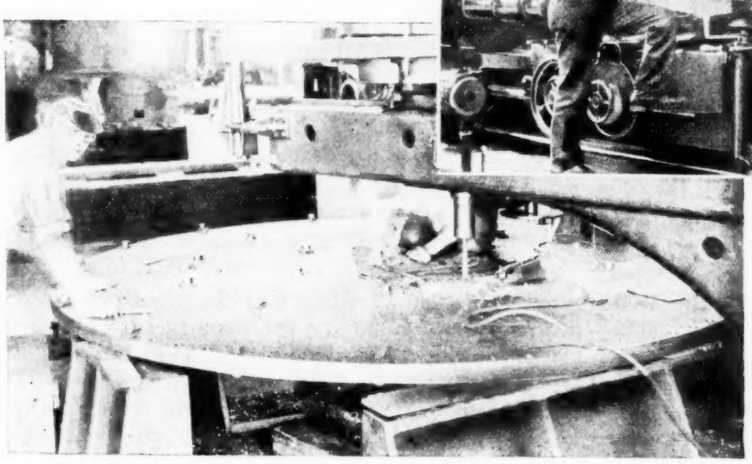
Right — Boring the high-pressure casing for the diaphragms



Left — Boring the low-pressure turbine bearing housings



Right—Cutting the blade grooves in the high-pressure drum



Left—Boring the holes in one of the condenser tube sheets

The Case for Low-Temperature Carbonization in America Today—II

By H. W. BROOKS*

THE first part of this article, printed in last week's issue, described various systems, reviewed European practice and suggested application to American conditions, especially in connection with central stations. The second part takes up the difficulties encountered and how they may be overcome, discusses the economic features and includes calculations as to actual costs which show up better than high temperature processes.

Difficulties Encountered in Low-Temperature Carbonization and Their Solution

Opponents of low-temperature carbonization base their arguments on the following points:

1. *Expansion and Shrinkage*—Coking coals soften, fuse and swell at temperatures in the neighborhood of 350 to 450 deg. C., resulting in internal stresses on the retort walls. At somewhat higher temperatures the plastic mass hardens and at still higher temperatures shrinkage takes place. Most semi-bituminous coking coals give considerable trouble in both high- and low-temperature processes utilizing stationary unagitated chamber retorts in which the raw coal charge is packed tight. Blending with higher-volatile coals must often be resorted to for successful coking. These difficulties are not experienced with non-coking coals. In neither of the two low-temperature processes previously described do these difficulties enter, for in both the cross-sectional areas of the retort are more than ample to provide for expansion.

2. *Lightness and Porosity of Coke*—The period of fusion and of gas evolution in low-temperature coking is not so abrupt as in high-temperature ovens resulting in puffing up the charge and enlargement of the cell spaces. The temperatures which cause subsequent shrinkage to take place in high-temperature ovens are seldom attained in low-temperature practice. The result is that the semi-coke produced is likely to be light and porous. In the manufacture of briquetted coke for domestic use this is indeed a disadvantage. In the use of coke in pulverized form under power boilers, however, its lightness, friability and porosity are decided advantages. Pulverizing (if any) and maintenance costs are decreased. A non-gritty pulverized fuel of high impalpable dust content is produced. This being light and flocculent, lacking in well-defined cellular structure and containing considerable volatile matter (usually about 10 per cent), lends itself well to speedy ignition and flame propagation; hence small furnace volumes per unit heat release. Its use in a "well" furnace would minimize the necessity of further pulverization subsequent to carbonization.

3. *Fusion and Sticking of the Coal Charge*—This fusion does not take place with non-coking coals. Operators, therefore, situated in the Middle West having available such non-coking coals as those of Illinois, Indiana, Kentucky or Iowa, need give this problem little consideration. It should also be noted in passing that tests of the Bureau of Mines demonstrate that the lower the class of coal the greater the exothermic heat[1] release of the carbonization process, hence the less the fuel and operating expense. The brightest economic possibilities, therefore, for low-temperature coking are offered to low-grade coal users in the central stations of the Middle West.

With coking coals, however, the process of carbonization produces a sticky viscous material difficult to handle mechanically and to heat uniformly. Earlier methods experienced considerable difficulty due to the tendency of coking coals to stick on the stirrers and retort walls, as well as in securing proper distribution and uniform flow of hot gases through the retort. That present-day designs, however, have completely and satisfactorily overcome this difficulty is best evidenced by the successful demonstration last summer in England, for the writer, of the processing of an English coal of high coking index in the "Fusion" rotary retort with absolutely clean walls and stirrers and by a similar demonstration in the United States in a Carbocoal retort at Fairmont, W. Va. In carbonization in pulverized form in vertical retorts this difficulty has not been encountered, as the period of fusion is equally, if not more, abrupt than in high-temperature ovens, owing to the relatively speedy heat penetration through the fine coal particles.

4. *Accumulation of Hard Coke*—On the earlier horizontal cylindrical retorts the coking coals which during the plastic stage adhered to the retort walls, carbonized to a hard coke which interfered with the operation of the agitating devices and seriously affected efficient heat transfer. The two demonstrations cited prove that this difficulty has been overcome in present-day designs. In the vertical pulverized-coal retorts the difficulty has not been encountered for the same reasons noted in the preceding paragraph. With poorly coking or non-coking coals fusion does not take place.

5. *Artificial Destruction of Coke Properties.*—Weathering, slow heating and oxidation of coking coals decrease their value for the manufacture of high-temperature coke. These conditions being inherent to certain processes of low-temperature coking, are a liability if solid or briquetted domestic fuel is contemplated. They are an asset, however, for systems contemplating

*Consulting engineer, Fuller-Lehigh Company, Fullerton, Pa.

[1] A process that gives off heat.

the combustion of pulverized semi-coke in boiler furnaces, as the destruction of the coking properties for such purposes is to be desired for reasons previously indicated in paragraph 2.

6. *Materials of Construction*—It is contended that the temperatures of low-temperature distillation of 400 to 600 deg. C. (752 to 1,112 deg. F.) are just too low for satisfactory employment of refractory materials and just too high for satisfactory employment of metals. The commoner refractory materials are further condemned for poor thermal conductivities, liability of leakage and high maintenance costs. For these reasons, in the processes recommended for pulverized carbonization (excepting one in which silicon carbide is utilized), they are not employed. Iron and steel retorts, however, *are* employed and it is argued that at these temperatures they are lacking in durability and tensile strength and are likely to warp, distort and break through absorption of carbon. In Germany some difficulties were encountered in rotary retorts from warping of steel shells. The subsequent successful operation of these German rotaries as well as of the Fusion rotaries in England and Esthonia, and the Carbocoal rotary at Fairmont, W. Va., tends to indicate that these earlier problems have now been successfully solved.

That available metals are successfully standing up under conditions quite as severe in other services is indicated in the following examples. Cast-iron retorts have for years been successfully employed in Scottish shale-oil distillation at temperatures in excess of those required for coal. The use of the same material for coal carbonization at H. M. Fuel Research Station at London has not yet developed operating difficulties. The cast-iron bells in vertical cement clinker coolers give satisfactory service at temperatures far in excess of those used in low-temperature carbonizing. Mild-steel retorts under heat more or less continuously for 18 months at H. M. Fuel Research Station at London in which the temperature was controlled not to exceed 600 deg. C. showed "no trace of scaling or corrosion and the retort appeared to be in exactly the same condition as when it was first installed." Other retorts in similar use three years "do not appear to have suffered in the slightest degree." Though the forging would indicate no immediate need for further developments of retort materials where the temperatures are properly controlled, there are today available within reasonable price range numerous alloy steels and cast irons which maintain excellent rigidity up to 750 deg. C., several of these being guaranteed for still more severe conditions. The use of silicon carbide retorts would appear to combine the advantages of high heat transfer with the ability to withstand much higher temperatures should same prove desirable.

7. *Quenching*—Considerable heat is lost in quenching in all distillation processes producing coke for domestic or metallurgical purposes. Low-temperature coke, being light and porous, is often difficult to cool economically without producing a material of excessive moisture. But when the coke is being burned as fast as produced, not only does this difficulty automatically disappear, but the heat content of the hot coke here conserved becomes a valuable asset (like preheated air from air preheaters) not only in increasing efficiency and speed of combustion, but in decreasing combustion volumes. If for any reason cooling of a portion of the semi-coke (for example, to be sold as domestic fuel) should become desirable, it may be effectively accomplished by allowing it to cool in a water-jacketed gastight heat interchanger, the resultant steam being utilized, or by the Sulzer or Collin processes,[10] cooling with gases.

8. *Spontaneous Combustion*—It is argued that the light spongy low-temperature coke is prone to spontaneous combustion and dangerous to store unless well quenched with water. This seems reasonable if carbonized in solid form for domestic service in view of its being more easily ignitable and freer burning than high-temperature coke. But when utilizing the semi-coke in pulverized form under power boilers as fast as made, there is no more need of storage than in the direct-fired or "unit" pulverizer system. In fact, in base-load power plants it would seem logical that the coal feeder system should be designed in much the same manner, regulating the furnace feed of semi-coke from the raw-coal end.

9. *Difficulty of Forming Salable Fuel in One Operation*—Separate briquetting is expensive. Though some solid coke suitable for domestic use may be formed if desired in the horizontal cylindrical retorts previously described, the best possibilities for production of domestic fuels seem to lie in unagitated chamber retorts in which all the problems of expansion, sticking, etc., previously mentioned appear. But carbonization by the methods suggested at power plants provides a steady market for the semi-coke breeze. In fact fuel in pulverized form, ready for combustion, is so desirable that plant operators pay from 40 to 55 cents per ton (fixed charges included) to get it in that form, in order to save 10 to 25 per cent in fuel cost over any other known means of utilization.

10. *The Heat-Transfer Problem*—With the lower thermal head necessary the problem of rapid conduction of heat if refractory walls are used becomes somewhat more difficult than with high-temperature processes. But where the coal is finely divided and constantly agitated in thin layers in direct contact with heated metal walls, the mixing mechanism constantly displaces the carbonized layer with fresh material, thus materially shortening the carbonization period since the coal can be turned over and brought to the heating walls much faster than heat can be made to flow through layers of material already carbonized. The thermal conductivity of thin metal or silicon carbide walls is many times greater than that of common thick refractory walls. As a result much higher throughputs per unit of ground space and far shorter coking periods than are possible in high-temperature ovens are obtained. This has been repeatedly demonstrated by commercial-scale operating processes.

11. *Power and Maintenance Costs of Processes in Which Coal is Prepulverized or Stirred in Contact with Heated Surfaces*—Today, it is generally admitted (in the words of the Pennsylvania Giant Power Survey Board) that "the most efficient known method of generating power in very large quantities is by the use of powdered fuel under steam boilers." This being the case, the cost of coal drying, of power for pulverizing (which is little if any greater than that required during or prior to carbonization), as well as most of the necessary maintenance is inherent to the process of most efficient power production. Excess power and heat re-

[10] Illies, H., *Neuerungen im Kokereiwesen*, *Brennstoff Chemie* 5 161-6 189-95, 234-40 (1924) June 1 and 15 and Aug. 1 issues.

quired for drying and carbonizing over that necessary for pulverized-fuel preparation would be almost negligible.

No matter how technically feasible a process may be, the eventual measure of its service to society must necessarily lie in its dividend-paying possibilities Without being convinced of them, the financier or banker will quite properly never supply the vitalizing force—money—which allows the process to see the light of day as an operating plant. Consideration of these necessarily involves a careful study of the costs of raw materials and of manufacture, the character and quantity of the yields of the products to be manufactured and the market prices obtainable for them.

Economics of High- and Low-Temperature Carbonization Processes Compared

In order to treat of these economic phases with utmost conservatism, both as to comparison of high- and low-temperature process costs as well as to the actual profits to be derived from whatever method proves most promising financially, it is proposed to accept as a basis for discussion a formula developed by an opponent of low-temperature carbonization, F. W. Sperr, Jr.,[11] chief chemist of the Koppers Company. His conclusion therefrom is that low-temperature carbonization must overcome a handicap of from $0.75 to $1.35 per ton of coal (depending upon prices of tar and gas) to compete with the high-temperature process employed by his company. He does, however, qualify his conclusion by stating that "in the application to power production some of the difficulties of low-temperature carbonization disappear," and that "it might be possible to employ the semi-coke in pulverized form, though comparative costs and efficiencies in this connection have not been thoroughly worked out."

Mr. Sperr gives as the comparative yields from the byproduct coke oven and low-temperature processes the following:

	By-product Coke Ovens	Low-Temperature Carbonization
Gas (550 b.t.u. equivalent), cu.ft.	11,500	6,000
Tar, gal.	12	20
Motor fuel, gal.	2.6	2.6
Ammonium sulphate, lb.	25	10
Coke, pct.	58	66

For these he assumes the following prices:

	By-product Coke Ovens		Low-Temperature Carbonization	
Gas at 30c. per 1,000 cu.ft.	$3.45		$1.80	
Tar at 5c. per gal.	.60		1.00	
Motor fuel at 20c. per gal.	.52	= $1.87	.52	= $1.82
Ammonium sulphate at 3c. per lb.	.75		.30	
	$5.32		$3.62	

From these data he deduces the formula for high-temperature operations as

$$0.58X + 11.5G + \$1.87 = F + C$$

and for low temperature operations as

$$0.66X + 6G + \$1.82 = F + C$$

where

C = Price of coal in dollars per net ton;
G = Price of gas in dollars per 1,000 cu.ft.;
X = Price of coke in dollars per net ton;
F = Sum of operating charges, fixed charges and profit.

The figure of $1.35 he deduces in favor of the high-temperature process is obtained by solving the formulas on the basis of *equal fixed and operating charges* and profits (F), equal coal costs at $5 per net ton ($C$), and *equal gas selling prices* of 30c. per 1,000 cu.ft. (G). It should be noted in passing that the application of these figures to the high-temperature formula shows the figure F of operating and fixed charges plus profits to be $3.25 when coke sells for the same price per ton as the original raw coal. There are several facts, however, some of which are particularly applicable when the low-temperature coke is subsequently burned in pulverized form in power plants, which this formula fails to take into account.

First, let us consider oil prices. "Low-temperature tars are thin and light, having a consistency much more resembling oils."[12] They "contain more phenols (tar acids), more neutral oils (napthalene and paraffins) than high-temperature tar. The neutral hydrocarbons are quite similar to ordinary kerosene."[13] Having a higher percentage of low-boiling constituents and probably a lower percentage of soft light pitch containing much less free carbon and of lower melting point, it lends itself to the production of creosote oil, lubricating oil and greases. Though not considering tar cracking in this discussion, it is of interest that the crude low-temperature tar from one ton of coal will refine to produce about 5.5 gal. of tar acids containing much creosol, 1.7 gal. (additional) motor gasoline, 8 gal. of neutral oil and 12 gal. of pitch. High-temperature tar, on the other hand, being the product of secondary decomposition, produces a dense viscous tar high in free carbon and the aromatic hydrocarbons (naphthalene, anthracene, etc.). Now, it is quite proper that in comparing the two carbonization processes with respect to their primary products, as has been done both by Mr. Sperr and in this discussion the economics of tar distillation plants should not be entered into. Certainly, however, when one of the primary products is obviously and fundamentally more valuable in one process than in another, due credit must be given. It is well recognized that the imminent decline in the supply of petroleum will create an intensified demand for the petroleum—like oils of low-temperature carbonization. It is a fact that one producer here in America is today selling his low-temperature tars at 7 cents and another at 6 cents, in a yet undeveloped market, and it would seem probable that, owing to the greater content of constituents so valuable for wood preservation and chemical manufacture, the value of these tars should further increase. In England, Lander[14] estimates the value of these tars at five pence (10 cents) per gallon, while Brownlie[15] estimates them at 4½d. (9 cents). Under the circumstances, it certainly would be conservative to figure low-temperature tar oil prices at 7 cents, which is now actually being obtained in America for them.

Secondly, let us consider tar oil yields. As against a total oil and motor-spirit yield figure of Sperr of 22.6 gal. (20 gal. tar, plus 2.6 gal. motor spirit), the Carbocoal process has averaged 28 U. S. gal., while the Fusion process with British coals and an exceptionally low temperature of carbonization has averaged 4.8 to 6 U. S. gal. of motor spirit in the tar (3.6 to 6 U. S. gal. stripped from the gas) plus 12 to 24 gal. of dry paraffinoid oils. Thus, though there is every reason to

[11] Sperr, F. W., Jr., "Practical Coal Carbonization," *Mechanical Engineering*, Vol. 46, No. 6, pp. 329-33 June, 1924.

[12] Parr, S. W. and Layng, T. E.—*Journal of Industrial and Engineering Chemistry*, Vol. 12 (1921) p. 14.

[13] Sperr, F. W., Jr.—*loc. cit.*

[14] Lander & McKay, "Low Temperature Carbonization" (Ernest Benn, Ltd.), published 1924.

[15] David Brownlie, "The Fusion Rotary Retort Process," *Combustion*, Vol. XII, No. 1, pp. 44 to 50, Jan., 1925.

believe both the motor spirit and total oil yields higher than shown in the formula, the original figures of 22.6 gal. will be accepted in order to be ultra-conservative.

Third, the coke yield for the low-temperature process is undoubtedly low at 66 per cent unless this is the estimate of net yield after the coke necessary for the producer that heats the retorts has been deducted. In this latter case the operating charges later estimated in this paper as chargeable against low-temperature carbonization will be too high to the extent of the value of 4 to 9 per cent of the total coke values. The Carbocoal and Fusion processes both secure 75 per cent coke yield, and this apparently represents a fair average secured by a number of European plants visited by the writer last summer.

Higher Heat Value Gas Should Bring Higher Price

Fourth, it seems highly probable that the price obtainable for the high (800 to 1,000) B.t.u. low-temperature gas which is so valuable and desirable for the enrichment of leaner gases from water-gas producers or high-temperature coke ovens should be higher per therm than relatively lean high-temperature gas. Inherent advantages of gas as a fuel for heating, both domestic and industrial, together with rapidly failing sources of natural gas, are creating an intensified demand for gas obtained from coal. Manufacturers of enriched blue-water gas are today paying approximately 20c. (3 + gal. gas oil @ 6½ to 6¾c. per gallon) per 1,000 cu.ft. to enrich 300 B.t.u. water gas to 520 B.t.u. No reason is immediately apparent why they should not gladly pay 40c. per 1,000 cu.ft. for low-temperature gas which would accomplish an equivalent enrichment with marked savings over present costs. Having no definite proofs available, however, that such prices have been obtained, the continuance of a conservative viewpoint demands the acceptance of the equivalent gas prices of the formula.

Fifth, the prevailing installation cost estimates on large plants of practically all low-temperature carbonizing processes of the types recommended herein are about $600 per ton of daily capacity. They range as high as $1,000 per ton day on small plants of, say, 250 tons daily capacity. These figures have been checked by the author with cost data of a large manufacturer building and installing equipment of similar character and found to be ample to cover all labor, materials, overhead, reasonable royalties and an ample margin of profit. Known investment costs for standard byproduct coke ovens range from $1,800 to $2,400 per ton day. Certainly, therefore, the fixed charges on the investment for low-temperature ovens should not be equal, as suggested by Sperr, but should be considerably less than half those of the high-temperature method. As plants of fairly large size are contemplated in this discussion, the very conservative figure of $800 investment per ton of daily capacity will, therefore, be employed in subsequent calculations of fixed charges.

Sixth, not only were the fixed charges assumed the same to produce the results unfavorable to low-temperature methods, but also the operating expense. This latter comparison is equally untenable, for if the heat used for carbonization plus subsequent condensation of distilled products is anywhere near the relative carbonizing temperatures (1,700 to 2,000 deg. F. vs. 900 to 1,300 deg. F.) as one would logically expect, the fuel requirements would be lessened approximately in the ratio of 100 per cent less $\frac{1,100}{1,850}$ or nearly 40 per cent. This takes no account of greater efficiency of heat transfer through metal or silicon carbide walls to constantly agitated, thin layers of coal as compared to that through the refractory walls of coke ovens to the thick unagitated coal charge within, nor of the greater combustion efficiencies obtainable with the larger furnace volumes economically feasible in low-temperature processes. Furthermore, the latter, being continuous in operation and of high throughput, labor charges are considerably less. In England, by the Fusion process, total operating expense, including maintenance, has been found to be three shillings[16] (about 60 cents), while here in America by the Carbocoal process they have been shown to be about seventy cents[17] per ton of coal carbonized. In order to be ultra-conservative, however, in subsequent calculations, a figure of $1 per ton will be employed.

Seventh, Mr. Sperr estimates boiler efficiency in a stoker-fired power plant burning 1,060 tons of combined high-temperature coke and breeze at 78 per cent. Though the writer has never seen tests demonstrating such efficiencies under these conditions, it is conceivable that they might be possible with superheaters, economizers and air preheaters. Under similar conditions, pulverized fuel has shown efficiencies as high as 90 per cent.[18] With the methods proposed, therefore, pulverized low-temperature coke would enjoy an inherent advantage in the ratio of $\frac{90}{78}$ or 1.15 over high temperature coke burned on stokers. Furthermore, in steamed retorts, Fieldner has observed[19] that "the steam undoubtedly activates the carbon to a certain extent, . . . due to the steam activation (the semi-coke) is easily ignited and readily combustible." Again, the pulverized fuel being delivered dry, hot and in finely divided state, would have chargeable against it no dryer and little if any of the pulverizing expense which would ordinarily be chargeable against pulverized-fuel operation.

Summing up, therefore, it may be conservatively estimated that the methods proposed deliver to the boiler furnaces a fuel beneficiated at least to the extent of 17 per cent over high-temperature coke burned on stokers, due to the greater inherent economies of the process to which it is adapted and the more desirable form in which the fuel is delivered.

Recalculation of Sperr Formula

It will be recalled that in the previous calculation quoted, the exponent of byproduct coke ovens assumed the value of his coke to a power-plant operator as equivalent to that assumed for raw coal. This is obviously incorrect for high-temperature coke mixed with breeze, first, because it is not ordinarily as efficient nor desirable a fuel when burned on chain-grate stokers as is raw coal on underfired superstokers, and second, because its B.t.u. value is less. The figures quoted as-

---

[16]Brownlie, David—"The Fusion Rotary Retort Process," *Combustion*, Vol. XII, No. 1, Jan., 1925, p. 50.

[17]Penn, "Giant Power Survey" Report, Feb., 1925, p. 379.

[18]Kreisinger, H. "A Review of Recent Applications of Powdered Coal to Steam Boilers," *Mechanical Engineering*, Vol. 47, No. 1, Jan., 1925.

[19]Fieldner, A. C. Serial Report of the Prime Movers Committee, Technical National Section, N.E.L.A., on "Foreign Developments," July, 1925, p. 39.

sumed a 14,000-B.t.u. coal to give 13,200-B.t.u. coke, either for high- or low-temperature carbonization. Though the results of analyses have generally proved more favorable to coke from the latter method, in order to keep the results as parallel as possible, these figures will be accepted for purposes of comparison.

The high-temperature formula then becomes

$$0.58\ \frac{13,200}{14,000}\ X + 11.5G + \$1.87 = F + C$$

or by transposition and substitution ($5 coal and 30c. gas) the sum of *fixed charges, operating expense and profit* (F) becomes

$$F = 0.58 \times \frac{13,200}{14,000} \times \$5 + 11.5 \times \$0.30 + \$1.87 - \$5$$
$$= \$2.68 + \$3.45 + \$1.87 - \$5 = \$3$$

Now, similarly substituting the new figures of 7c. for high-temperature oils, a 75 per cent coke yield, 17 per cent beneficiated, together with known operating expenses of $1 per ton (see sixth item) and fixed charges based on a conservative low-temperature plant cost of $800 per ton daily capacity (see fifth item) the detailed balance sheet for the low-temperature process becomes as follows:

Ammonium sulphate, 10 lb. at 3c. per lb.	$0.30
Tars, 20 gal. at 7c. per gal.	1.40
Motor fuel, 2.6 gal. at 20c. per gal.	.52
Gas, equivalent of 6 M. of 550 b.t.u. at $0.30 per M.	1.80
1,500 lb. coke beneficiated in the ratio $1.7 \times \frac{13,200}{14,000} = 1.10 \times 0.75 \times \$5$ per ton	4.12
Total income per ton	$8.14

Necessary expenditures per ton become as follows:

Investment charges, interest, depreciation and taxes per ton at 20 per cent* on $800 investment	$0.44
Operating charges, fuel for heating retorts, power, water, labor, maintenance and supplies	1.00
Miscellaneous and overhead	.10
Coal per ton.	5.00
Total cost per ton	$6.54
Profit per ton in low-temperature carbonization	$1.60

* This charge has purposely been taken high to cover contingencies, amortization, etc.

Now, refer again to the combined *fixed charges, operating expense and profit* of $3 a ton previously figured for coke-oven operation. The application of the same figure of 20 per cent to cover investment charges, interest, depreciation, taxes, amortization and contingencies on a high-temperature coke-oven plant costing $2,000 per ton day reveals fixed charges alone amounting to $1.10 per ton processed, leaving a total of, but $3 — $1.10, or $1.90 per ton, to cover *both operating expense* and profit for the high-temperature process. It is interesting that the *profit alone* for the low-temperature process figures within 30c. per ton of the total profit *and operating expense* of the high-temperature method, leaving little doubt that the former offers far greater money-making possibilities for the central station than the latter.

Where Cheap Coal Is Available

Now it appears probable, owing to the industrial concentrations near the coal-producing districts of the United States and the enormous demands for electrical energy in these regions, that at least the first installations of the character proposed will be located where slack or screenings could be purchased much cheaper than $5 a ton. In order not to change the B.t.u. figures employed, consider for the moment a prospective plant location in Pennsylvania or West Virginia, at or near a mine mouth, where 14,000 B.t.u. coal could be purchased for, say, $2.50 per ton. Then again employing the same formulas, the total fixed charges, operating expense and profit for the coke-oven process would be increased to $4.16 a ton, from which the same deductions for investment charges of $1.10 would leave but $3.06 a ton for total operating expense and profit. On the other hand, the prospective *profit alone* for the low-temperature process would by similar treatment become $4.28 per ton, or 40 per cent more than the total operating expense and profit for the coke-oven process. *Under such conditions the entire fuel for power could be delivered into the boiler furnaces as of no value and the carbonization process would still show a reasonable margin of profit.*

Conclusions

1. Economic and technical conditions in Europe being quite different from those in America, a different solution of carbonization must be worked out here to earn dividends at this time.

2. Low-temperature carbonization is adapted more adequately to dividend-paying possibilities in America today than byproduct coke-oven methods, on account of lower operating and investment costs, higher oil and richer gas yields and (in certain processes recommended) the delivery of a finely divided, easily ignitable coke, which may be more efficiently utilized for power generation.

3. The preferred process of low-temperature carbonization should either carbonize the raw coal in pulverized form or pulverize and carbonize simultaneously, thereby furnishing a beneficiated coke to power plants which offer a permanent and continuing market without subsequent transportation charge on the yield of the only heavy low-priced product of the process.

4. The disadvantages, technical and economic, of low-temperature carbonization, ascribed by its opponents, largely or entirely disappear when the recommended methods are subjected to analytical consideration.

5. The processes recommended are not only technically but financially feasible and apparently offer to American power-plant operators the only well-considered probability of further large reductions in fuel costs.

6. The most favorable location for laying down an early installation of low-temperature carbonizing equipment in connection with central power stations is in the Middle West. There cheap, low-class, non-coking or weakly coking bituminous coals can be converted into much-needed oils, rich gas, ammonium sulphate and highly beneficiated, pulverized semi-coke more suitable for efficient power production than the original coal from which it was made. In such a plant, even at present market prices, the sale of primary byproducts would probably pay the entire cost of the process, delivering to the boiler furnaces for power generation, fuel that represents clear profit, hence costing nothing.

7. In a large, efficiently operated central power station employing competent combustion engineers and boiler-room chemists to secure constantly maximum continuous operating economies in fuel consumption (of which there exist an increasingly large number in the United States), there are already available competent personnel to manage, supervise and operate the necessary additional carbonization equipment.

8. In combined gas and electric properties the operation of the byproduct plant in connection with the central station would lessen coal storage and unloading expense and would afford the gas plant a means of getting rid of waste products as well as a steady cheap supply of enriching gas.

Langley Field Research on High-Speed Oil Engines

IS THE high-speed oil-engine possible? Although the Langley Field's experiments prove that it cannot be made of a converted gasoline engine, they point the way to ultimate success.

By ROBERTSON MATTHEWS*

MUCH interest has been aroused here and abroad over the prospects of the oil engine of the high-speed type. The successful production of such an engine to turn at 1,200 r.p.m. or higher with a weight of under 6 lb. per brake horsepower will do much to increase commercial flying, etc. Even in such services as trucks, automobiles and the like, the oil engine would possess certain advantages over the carburetor engine in smoothness of operation at low loads and in a greater efficiency brought about by the higher compression pressure possible.

In taking up the experimental work at Langley Field a Liberty airplane-engine cylinder was placed at the disposal of the force, together with Liberty running parts, with the exception of the piston and crankshaft.

Unfortunately, the crankshaft has been designed to use Liberty-6 brasses, and these were pounded down by the high pressures. Harder bearing metal was substituted, but at the expense of wear on the journals. A piston of aluminum alloy, extending far enough above the rings to give nearly an 11.5 volumetric compression ratio was substituted for the standard Liberty piston, which gave only 5.4 compressions. The three ¼-in. Liberty rings were retained, and the piston skirt lengthened to help balance the extended piston head. Since the Liberty wristpin had been retained, the piston bosses swaged and cracked under the heavy gas pressures.

The Injection Pump

A spring-actuated injection pump was developed, the ½-in. plunger of which was lapped and used in a lapped bushing without packing. The pump's suction stroke took place under the primary pump pressure. A radial cam, operating at one end of a rocker arm, compressed a heavy coil spring, and when the rocker dropped off a step on the cam, the spring pressure drove the injection plunger forward on the discharge stroke. The metering was done by changing the position of a positive stop, against which the cap over the end of the actuating spring came to rest. The plunger had, therefore, almost a hammer-blow start and an abrupt stop. It was found that with sufficient spring load to give a hard stop the mechanism could not stand the shock. With a less spring compression the plunger velocity would slow up toward the end of the stroke. Since there can be no discharge till the fuel pressure is built up in excess of the spring load on the nozzle, the hammer blow at the start is not only unnecessary, but introduces design difficulties; but the positive stop at the end of the discharge stroke is desirable.

Since the Liberty uses two spark plugs in each cylinder and the valves are the maximum diameter possible, the only location for the fuel-spray nozzle was in one of these spark-plug holes. This restricted the diameter of nozzle parts; but, on the other hand the body could be made relatively light and short compared with what is required on oil engines where the nozzle body must extend through the thick cast-iron walls and generous water-jacket space.

A bronze gear pump, such as is used on screw-cutting machinery, was used as a primary pump to supply the injection pump with fuel at around 100 lb. pressure. Ordinary copper tubing was used between the primary and the injection pumps. For the high-pressure side ¼-in. steel tubing was first used and later ⅜-in. tubing was tested. It was found that the tubing should be reamed before assembly, so that any vibration and bending does not throw scale into the fuel. With this provision one strainer, between the two pumps, was found sufficient. Ordinary ⅜-in. copper tubing withstood 7,000 lb. pressure, but vibration caused it to open up near the couplings. For the steel tubing, special soft-steel compression couplings were used, silver soldered to the tubing. The method of making the joint by compressing against the swaged end of the tube is preferable to the soldering and seems to withstand vibration better.

Faulty Combustion Chamber

The combustion chamber form of this adapted cylinder was unusual in that the cylinder had a considerable flare at the top. The required extension to the piston head to give about 11 compressions, left almost no space between the piston and cylinder heads at top dead center, the combustion space consisting in the main, of a ring about the top portion of the piston, as indicated in Fig. 3. The result might be considered as an extreme case of the Deutz or Crossley piston design; but instead of a knob projecting into the combustion chamber the entire piston head, in this case, moves in. While this arrangement creates turbulence, at the same time it destroys the possibilities of the formation of a hot ignition zone. It also segregates the air charge into two portions, one a thin sheet across the top of the piston head, the other, a thin annulus around it. The compressed air was thus crowded up against the water-jacket surfaces. To what extent the extremely large exposure of piston head neutralized the cooling effect of the jacketed surfaces, it is difficult to deduce.

The spray-nozzle tips used in the initial experiments had but a single hole; three diameters were tried, namely, 0.012, 0.014 and 0.018 in. These orifices were situated at the side of the tip with a few degrees downward inclination, causing the jet to discharge across the top of the piston rather than at it. To accommodate this jet the piston head had to be fluted in the form of a half cone having a diameter at the larger

*Formerly Research Experimental Engineer at Langley Field.

end of about two inches. Such a channel gave room for the jet to spread out.

The plain orifices give too much penetration, and as a result, the fuel landed on the water-jacketed side of the combustion chamber. Evidence of this was shown not only by smoke, but also by carbon on the edge of the piston. One nozzle tip was tried with two 0.012-in. openings, one below the other, but the results were not satisfactory. Smoke occurred on all the runs and became heavy when the cylinder was yielding not over $\frac{1}{5}$ of its normal output with carbureted gasoline, the brake mean effective pressure being around 40 lb. Heavier loads were carried with these nozzles, but only under conditions of extreme fuel delivery.

A Different Nozzle Needed

Since better atomization was clearly necessary, a new form of nozzle tip was made. The whirl, or centrifugal, type would have required more room between the orifice and the piston to take full advantage of the jet, hence the impact type of tip shown in Fig. 2 was designed for this particular cylinder. The short distance between the orifice and lip, or impact surface, allowed the jet to impact before any dispersion of the fluid had occurred, giving the advantage of impact under full force of discharge. If the angle of impact was made too near the normal, considerable upsplash occurred, with fuel re-collecting on the body of the nozzle tip. On the other hand, an excessive slant narrowed the width of the fan-shaped jet and increased penetration. Even though the lip at its greatest width was not over $\frac{1}{8}$ in., the jet, when observed in free air with the aid of an oscilloscope, showed a dribbling

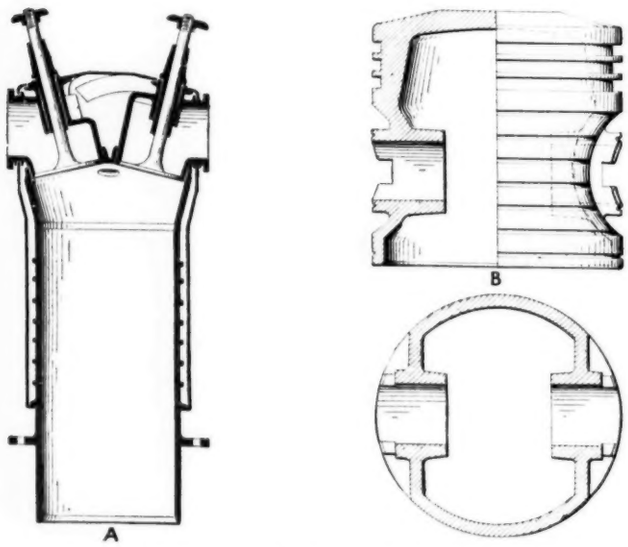


Fig. 1—Liberty cylinder and standard piston

effect, due to the spread of the fluid on the lip. Whether this same spread and dribble occurs when the nozzle is surrounded by combustion chamber flame is unknown. This lip stood the wear of the jet, but the tests were not long enough to prove the commercial worth of the design.

Proposals were made to enlarge the lip sufficiently to serve as a hot spot. But when it is recollected that there is practically no time for contact and that the amount of heat required to vaporize the fuel is out of all proportion to the rate at which heat could be supplied to the lip, it will be understood that the function of this lip is one of atomization only. A minimum surface is desirable, of course, to reduce spread of the jet and consequent dribbling. This design is suitable for kerosene and light gas oil, but not for heavy gas oil.

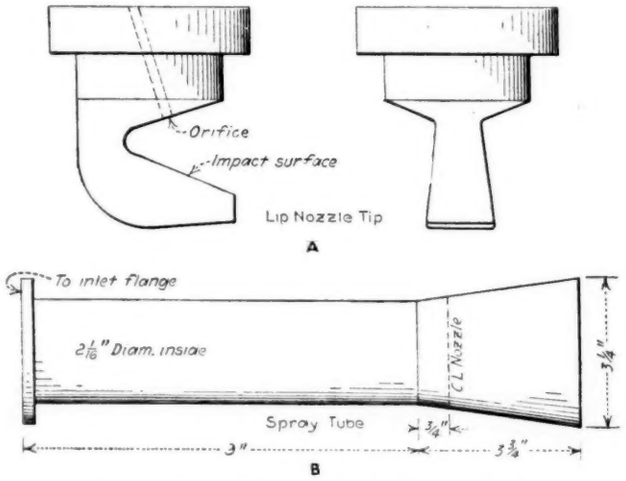


Fig. 2—Spray nozzle tip and nozzle tube

It was found that with the latter fuel an arc of carbon accumulated at the rear side of the jet and encroached on the impact spot.

In all the subsequent compression ignition operation the lip nozzle was used, the orifices going up to 0.026 in. The engine started more readily when using the 0.014-in. orifice, although for the attempts at high capacity an 0.018-in. orifice, or larger, was better. Had a positive discharge, cam-actuated injection pump been available, instead of the spring-actuated, a shorter interval of discharge could have been obtained with the 0.014-in. orifice. The close approach of the piston to the cylinder head made it advantageous, when trying for engine capacity, to get the more rapid injection that is possible with the bigger orifices. Three reasons can be advanced for this advantage. The lower piston position, with a given timing of the pump cam, and hence the better combustion chamber form, during more of the injection period, gave a freer path for the jet. The amount of fuel present before the penetration of the piston into the combustion chamber set up considerable turbulence, and the increase in the time available for vaporization before the piston hotwell advanced on its expansion stroke gave better combustion conditions.

Early Timing Used

The timing of injection, in terms of crank degrees, had to be decidedly early. The beginning of the plunger stroke was timed for some runs as much as 90 deg. before top dead center, but this is not so remarkable when it is considered that the revolutions per minute was five to eight times that of most commercial oil engines. In terms of absolute time the angle of advance for the injection pump was not great. There was found a lag, between the appearance of the jet and the start of the plunger stroke of from 12 to 20 crank travel degrees. For favorable results actual injection had to start with the crank angle at 60 deg. or more ahead of top center. Since for these locations

of the piston the jet could not impinge upon it, the same considerations requiring the enlargement of the orifice when using a spring-actuated pump, demand early injection.

The life of the pistons was extremely short. At first the aluminum-alloy piston heads with the deep flutes had metal about ¼ in. thick. A rib under this flute,

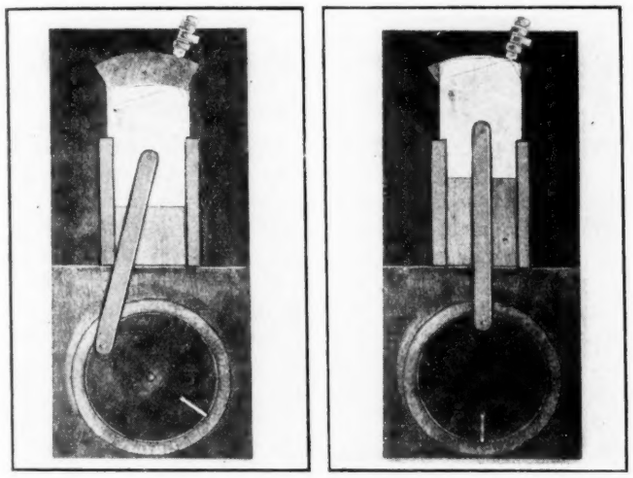


Fig. 3—Model of cylinder showing clearance

parallel with the wristpin, was tried, and also two ribs, one on each side of the flute. Since the use of the lip nozzle did not require a deep flute, alloy pistons having but a slight depression and five light ribs were next tried. This depression was only that due to having to have sufficient height to the piston, on each side of the spray path, to give the required compression. The life of these piston heads was a matter of minutes before cracks occurred. The amount of metal put into the tops of these heads was less than that of the regular Liberty piston, and the addition of ribs did not save overheating and failure.

Cast-iron pistons from the same pattern as the shallow-fluted alloy piston with the five ribs, were tried, but their excessive weight made speeds higher than 1,400 r.p.m. unsafe. The center of the heads showed brick red when removed after running on moderate loads. Zinc and lead plugs peened into holes in the top, close to the edge, were melted out. A similar plug of aluminum peened into a hole at the center of the head, also disappeared.

Magnesium Pistons Gave Fair Results

Finally, ribless magnesium pistons having heads about 0.5 in. thick were tried. The shallow depression of former heads was retained, but this did not amount to any appreciable irregularity that might become a local hot spot. One of these pistons stood short runs at 1,800 r.p.m., developing over 90 lb. brake mean effective pressure. A number of runs were made with this piston with a lesser m.e.p. without the head failing, although it began to show pitting and fine surface cracks.

There is reason to believe maximum pressures of over 1,400 lb. occurred even with this thick head and at moderate loadings. With these pressures and the excessive exposure to hot gases, due to the elongation of the piston beyond the rings, this piston, as well as the others, had severe punishment.

The unfortunate exposure of the piston head robs the experiments of what might have been learned regarding piston-head temperatures. Nevertheless, the problem of excessively high pressures, even with a more fitting design, calls for considerable attention in future experiments.

The compression pressure considered desirable was 325 lb., this being high enough for compression ignition with gas oil when running, but not for starting cold. While a higher compression would have improved economy and allowed the clean burning of a somewhat heavier fuel than the 34 Bé. used, the higher pressure was not considered desirable in view of the r.p.m. to be attempted and the possible maximum pressures.

Indicator of No Service

The explosive nature of the combustion made the taking of indicator diagrams difficult. A Mader micro-indicator was installed but was shaken to pieces. The only diagrams obtainable with it were those from the first explosions when the engine was started by motoring over with the dynamometer. Once the engine picked up its load, the indicator could not stand the vibrations. Finally, it was disassembled and so wired that the pencil could not jump ahead of the indicator piston; the smoked recording glass was also wired fast. This converted the instrument into a maximum pressure indicator.

Careful scaling of records showed maximum pressures at moderate loadings of about 1,600 lb. Since this seemed excessive, a light relief valve was built and calibrated for 1,300 lb., but even with light loads and the engine accelerating, this relief valve would pop continuously.

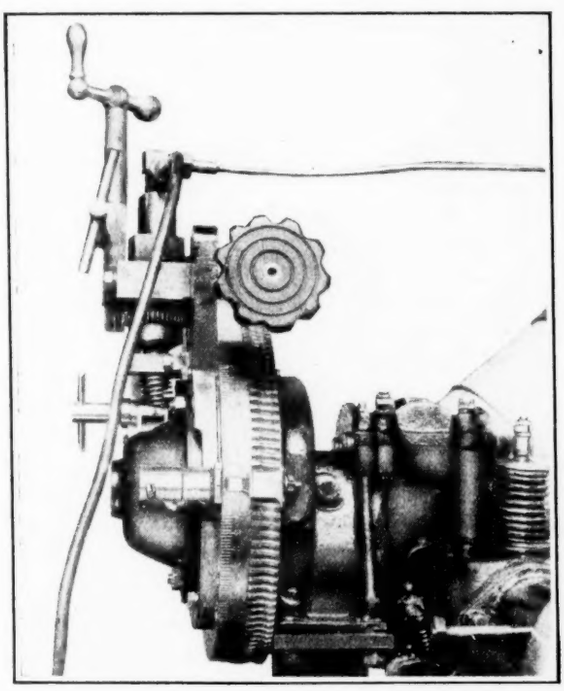


Fig. 4—Device to alter injection timing

The 11 to 1 compression ratio was sufficient to give clean burning at 1,700 r.p.m. and 55 b.m.e.p. Light-load runs were made with practically smokeless exhaust.

In the accompanying tabulations the indicated horsepower is taken as the sum of the brake horsepower and the friction horsepower, which latter was determined with the engine still warm from its power run.

Using gas oil and a lip nozzle with a 0.014-in. orifice, the average values obtained with one of the deep-fluted aluminum-alloy pistons, having only three ⅛-in. rings, running at approximately 1,700 r.p.m. throughout the series, were:

Brake horsepower	18.2	12.3	6.2	3.0
Brake mean effective pressure	60.0	41.0	20.0	10.0
Fuel per b.hp.-hour	0.64	0.66	1.17	1.78
Fuel per i.hp.-hour	0.42	0.37	0.47	0.44

The runs varied from five minutes to half an hour, a fixed weight of fuel being consumed on each run.

Using an aluminum-alloy piston having only a slight depression in place of the deep flute, but having five light ribs in place of one heavy one below the flute, gave these average values on gas oil:

Revolutions per minute	1,725	1,727
Brake horsepower	16.7	19.3
Brake mean effective pressure	56	64.5
Jacket water leaving, deg. F	167	174
Fuel per b.hp.-hour	0.55	0.61

The piston carried a load of 23.4 b.hp. for slightly more than three minutes when cracks in the head killed the compression.

One of the cast-iron pistons gave, as an average for close to a two-hour run when using the 0.014-in. lip nozzle, 60 lb. m.e.p. at 1,500 r.p.m.

Using a magnesium piston, a lip nozzle with 0.026-in. orifice and gas oil with anti-knock dope, the following average values were obtained for short runs:

Revolutions per minute	1,778	1,730	1,830
Brake horsepower	22	24.8	25.3
Brake mean effective pressure	74	83	79.6
Jacket water leaving, deg. F	135	140	135
Fuel per b.hp.-hour	0.58	0.66	0.74

On a snap run over 28 b.hp., above 90 brake mean effective pressure, was held only long enough to obtain steady running.

Cylinder Pressures Were High

Besides the evidence already given of high maximum pressures, cylinder studs were broken and water-jacket seams were opened on several cylinders in the neighborhood of the combustion chamber. While this is not an unknown occurrence with these cylinders during carburetor operation, the shortness of the running period before this occurred with compression ignition, would indicate hard running. That, however, the engine would gather speed, for some pump settings, would indicate freedom from preignition in the strict sense. It is worthy of note that with all the hard usage given to Liberty cylinders in these compression ignition runs, and six or seven were put into service successively because of jacket failures, there was never any apparent cylinder and cylinder-head distortion. These cylinder walls, though five inches in diameter, are less than ½ in. thick and the head is less than $\frac{3}{16}$ in. Patented types of rings were broken, as were also the regular Liberty rings, yet none of these cylinders had to be discarded because of any scoring from this cause.

A good output per cylinder of a Liberty airplane engine when using a carburetor, is 35 b.hp.; 23 b.hp. was obtained from this single cylinder for short, steady runs on compression ignition. High maximum pressures may be said to have killed the continuance of this research. When anti-knock dopes were used with the gas oil in an effort to get less explosive operation, one dope killed compression ignition entirely; another dope made starting more difficult but permitted an output of over 23 b.hp.

[*In a second article, to appear in an early issue, an account will be given of the two-stroke-cycle experiment at Langley Field.—Editor.*]

Fractures in Horizontal Engine Beds

By Edward Ingham

THE three principal causes of fractures in the bedplates of horizontal engines are: Unsatisfactory design; faulty casting; yielding of the foundations.

The all-important question of arranging the metal in such a way that it is best able to resist the loads imposed upon it, does not in many instances receive its deserved attention. While an exact determination of the stresses is a most difficult matter, and a designer must rely to a large extent on experience with other designs, nevertheless there are certain fundamental rules which, if observed, will reduce the risk of fracture to the minimum.

The metal should be disposed as nearly in line with the piston rod as possible. It is well known that a part is far more liable to fail under a bending load than under a purely tensile or compressive load of the same magnitude. Hence, when the metal is arranged at a considerable distance from the line of centers, subjecting the bedplates to excessive bending, there is more danger of a fracture than there otherwise would be.

A common fault is to use a higher frame than necessary, as appears from Fig. 1. If P is the piston load and X the distance from the center line of the crank-

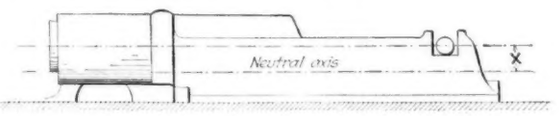


Fig. 1—High bed imposes bending stresses

shaft to the neutral axis of the bed section, the bending moment is PX, and this moment, and therefore the stresses in the frame, are reduced to the minimum by keeping the dimension X as small as possible, which is brought about by keeping the center line as low as practicable.

Another fault is to have the bedplate between the cylinders and the crankshaft bearing too shallow, as in Fig. 2. The effect of deepening the section is not only to strengthen the bed, but to bring the neutral surface of the section nearer to the center line of the piston rod and so reduce the bending moment.

A serious fault in design is the presence of sharp internal corners. The particles of metal arrange themselves in the direction in which the heat radiates from the cooling surfaces. In such corners there are two surfaces at right angles, and when the casting cools, the metal is highly stressed and fractures may originate at such places. Hence, all sharp internal corners should be provided with fillets. The danger of sharp internal corners was brought home when the sections of the famous Brittania Bridge over the Menai Straits on the coast of Wales were being raised. The cylinders of the hydraulic presses were made with flat bottoms and failed

repeatedly at the corners. Eventually, the bottoms were made hemispherical, eliminating all sharp corners, and no further failures occurred.

The desire to save metal and reduce the cost of production is responsible for some weak designs, weak in the sense that the thickness of metal is insufficient. Since it is not possible to calculate the loads with certainty, it is well to put plenty of metal into the design, and this is particularly so in the case of engines exposed to shock, as, for example, rolling-mill engines. One has only to observe the working of an engine with

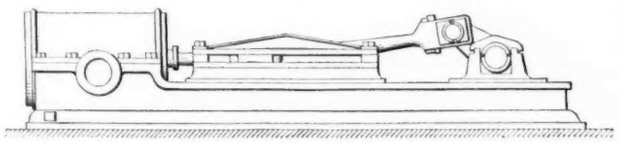


Fig. 2—A shallow frame section is inadvisable

a weak bed to realize the severe conditions under which the machine works. The whole engine will sometimes vibrate and groan like a creature in pain; a machine operating under such conditions cannot be expected to last.

The highest skill on the part of the iron founder is necessary for the production of a sound casting. Too often, beds are designed with objectionable features which render the work of casting a most difficult proposition for the founder, and result in the production of a casting possessing serious weaknesses. Cast iron is a metal that varies enormously in strength and shrinkage properties, and the production of a casting best suited for its purpose requires both chemical analysis and mechanical testing.

It is not difficult to realize that unless a long engine bed is evenly supported by the foundations, it will be subjected to bending stresses which may ultimately lead to its failure. Yielding of the foundations is probably the most common cause of these fractures. It is of fundamental importance that the foundation be set on suitable earth or, if such is not available, on piling or on a suitable rafting.

Usually, this matter is given every consideration, and more often than not, yielding is due to deterioration of the foundations themselves, particularly of the jointing material used in connection with brick or stone foundations. Lime mortar is unsuitable as a jointing material, because it tends to crumble and disintegrate under load. Cement should invariably be used.

Perhaps the principal cause of the deterioration of engine foundations is oil. In one plant a large pair of horizontal tandem compound engines were set on ashlar blocks jointed by cement. In course of time the foundations were allowed to get soaked with oil, causing the cement to soften and leading to a slight yielding of the foundation under the crankshaft end of one of the beds. Some time later the owners installed engines on the old foundations. Trouble was experienced from the beginning, and repeated attempts were made to patch up the foundations and make the beds more secure. The portion of the foundation under the crankshaft end of the right-hand engine main bearing sank enough to cause the bed to fracture.

In all cases where it is suspected that any part of the foundation has yielded, leaving the engine more or less unsupported, immediate steps should be taken to remedy the defect, either by realigning and grouting with cement, or by rebuilding the foundation. It is unwise to tighten up the nuts of the holding-down bolts until the engine is properly supported, since the effect of so doing is to impose bending stresses on the bed which may give rise to fracture.

Every effort should be taken to prevent oil from dripping on the foundation. This is particularly important if it is of concrete, because the effect of oil on this material is to render the concrete so soft that it is quite incapable of supporting any load. Undoubtedly the engine should be provided with oil catchers or drip-tins at every part where the oil is likely to fall.

Yielding of the foundations and consequent settlement of the engine throws undue strain on other parts than the bed, and there is no question that hot bearings, crankshaft fractures, etc., are in many instances due to this trouble. It is unfortunate that comparatively few power users ever think of having their engines tested for alignment. There is little question that if this practice were generally followed from time to time, crankshaft and frame fractures would become comparatively rare occurrences.

Fused silica (quartz), which has recently been developed to a commercial stage, gives promise of extreme usefulness in a wide variety of practical applications. Similar to glass in appearance, it differs markedly from glass in several particulars. The temperature coefficient being practically nil, it is not appreciably strained by unequal heating or cooling. Fused silica does not crack when heated red hot and plunged into water. It is remarkably transparent, not only to ordinary light, but also to the heat rays and ultra-violet rays at the two ends of the visible spectrum. A long rod heated white hot at one end will remain cool throughout most of its length yet burn a hand placed at the other end. In the same way ultra-violet light from a mercury-vapor lamp will pass through a long rod (curved or straight) and produce intense sunburn if it impinges on skin at the other end. This ability to conduct light and invisible radiation as water is conducted through a hose may lead to startling applications as yet unsuspected. Fused quartz will undoubtedly find important uses in medicine, optical apparatus, scientific instruments, etc. In the power-plant field it will probably be used for high-tension insulators, thermometers free from error due to heating and cooling strains, and for other purposes where high transparency or a low coefficient of expansion is desirable.

In discussing coal specifications the Prime Movers Committee of the N.E.L.A. states that ash content obviously affects the B.t.u. value in direct proportion, but in addition there is usually a falling off in efficiency as the ash content increases. Stated in another way, even if one assumes that coals of different percentages of ash can all be burned so that the refuse analyzes 20 per cent combustible, the coal of highest ash content will show the greatest loss to the ashpit and, other things being equal, the lowest efficiency. The actual value of the coal delivered in the bunkers is therefore adversely affected as the ash increases, due both to the falling off in B.t.u. value and in efficiency. The high cost of refuse disposal is in some cases an additional and important reason for avoiding coals of high ash content.

One Kind of Electrician

By N. L. Rea*

NOW and then new problems come up to break the even tenor of work. Some of these are amusing and one of the funny ones may be of interest. Two 75-kva. 2,300-volt generators with direct-connected exciters were sold to a customer in the mountains of South America. The order specified that the machines must be in pieces of 150 lb. or less for mule-back transportation. Step-down transformer, street lights and house-wiring supplies were included in the order. The customer was asked if we should furnish a man to assemble and erect. "No, thank you! We have an electrician of the highest character and ability and do not consider it at all necessary to have outside assistance." So we sat tight and wondered if the job would go through or fall by the wayside.

Six months later a letter was received that read about as follows: "Referring to the generators that we recently purchased from you. The first machine has been most carefully assembled and although we have tested it in accordance with all known electrical laws and with instruments, we can find no trace of residual magnetism. No, not even enough to attract a sewing-machine needle. We conclude, therefore, that the residual magnetism was left out at the factory. Will you please advise what you will do about it."

Form-Wound Coils a Puzzle

This seemed too difficult a problem for correspondence and an erecting engineer was started on the first boat. He found many interesting things. The electrician was a native of India who had operated a single-phase revolving armature generator and had done some simple house wiring in days gone by. This Hindu had made a fine mechanical job of the core and of the lineup, but had tried many weird and astonishing things. Form wound coils were beyond him. One coil went in right side up, the next one happened to be picked up the other side up and its curves reversed by a block and hammer. Persistent hammering got the coils in all the slots, the wedges in and clearance left for the revolving field. The coil terminals were bunched together, all the leads that would twist together grouped and another group made. No pole leads were used and the winding was not connected to the terminal board. More than two wires were outside their ken, so two of the terminals were fastened to one lead and the third used for the other side of a single-phase distribution.

"The oil switch was some curious sort of a trap that must have gotten mixed with this shipment." "Possibly time would tell what it was for," so it was set in the corner for future study and a snap switch from the house-wiring supplies used as a line switch.

The house wiring was well done, but the distributing transformer "caused them furiously to think" and the problem was solved as follows.

"The most powerful side of the transformer should be connected to the line. The winding with the largest wire must be the most powerful," so the 110-volt secondary was tied to the line and the 2,300-volt primary connected to the house wiring. Here was the making of a real time, but the old proverb, "A fool for luck," saved the day when the exciter was assembled. A piece of wire was connected to one side of each exciter field coil, the wire bent half around the pole, skinned for a short distance, doubled back on itself and the bight thus formed fastened in the terminal, the free ends of the wires then brought to a brush stud—any brush stud, for what difference could that make?

When the generator was started, they noticed the careless omission of the residual and this was the reason they couldn't get the lights to burn.

As luck would have it, the work on the second machine was held up pending the arrival of the man from the factory and the armature coils for the second machine were used in the first machine, and new coils ordered to replace those damaged by the winding methods.

The wiring, transformer connections and odds and ends were straightened up and arrangements made for a "grand opening." This was in the evening and all the world and his wife were there. About the time the generator was up to voltage and the lights turned on, someone asked the erector for a pail of water; he was told to take a fire pail from one of the racks.

A moment or two later the erector tumbled to what was going on. The Padre was about to exorcise the Devil from the equipment and had blessed the contents of the fire pail and was about to put it over the generator.

This problem required quick thinking and prompt, tactful action. The erector humbly begged the Padre's pardon and asked permission to make a suggestion. "Of course you know much more about driving out the Devil than I do, but from my long experience with machines I perhaps know better where the Devil is located. In this case there are two Devils, a very large one and a small one. The big one is in the wheel case here. You can hear him (the roar of the impulse wheel) and this machine makes the other one go. A drop or two of Holy Water and the correct sign will be ample for the little Devil in the generator, but the big one in the wheel needs a whole pailful." This reasoning appealed to the Padre, and the celebration went through without casualties.

The air lift operates on the principle that a column of dense liquid will support a higher column of less dense liquid. The water in the well surrounding the delivery tube forms the dense column, while the water in the tube, full of air bubbles, is the light column, which necessarily rises above the level of water in the well. To work properly, the delivery pipe must evidently be deeply submerged.

If the liquid that is measured by a venturi meter contains scale-forming material, it is possible for a quantity of scale to form within the neck of the venturi tube and materially increase the velocity of the liquid through the neck and thus give a correspondingly high reading. Therefore, tubes of meters of this class should be inspected occasionally.

The atomic weights of carbon and oxygen are 12 and 16 respectively. Therefore when carbon burns to form carbon dioxide (CO_2), 12 parts of carbon combine with 32 parts of oxygen by weight, or taking the pound as the unit, 1 lb. of carbon requires $2\frac{2}{3}$ lb. of oxygen for combustion.

*Contract Service Department, General Electric Company.

Boiler Inspection Legislation

MOST states have some kind of a provision for the inspection of buildings, factories, hotels, elevators, etc.

Some states have made it a part of the business of the Department of Safety, the Factory Inspection Department or some other existing or newly created bureau to see to it that none but safe boilers are installed in factories, hotels, department stores, theaters, etc., and that those installed are maintained in a safe condition and properly operated.

In all twenty-one of the forty-eight states of the Union have made such provision. What is stopping the rest?

The adoption of such legislation seems to have come to a stop. Is it necessary that there should be another Brockton disaster to arouse the public to its necessity?

A Nickel a Throw

COAL scoops vary in size, men in brawn, and coal in cost, but five cents is probably not far from the average value of a scoop of coal. Watch the fireman yank open the furnace door and heave in the plant's money—five cents, ten, fifteen, twenty, twenty-five, thirty! Slamming the door, he lights his pipe and rests for a minute or two. Then out swings the next door, and in goes the money—thirty-five, forty, forty-five, fifty, fifty-five, sixty—and so it goes from morning until night, and frequently all night as well.

Many hand-fired plants could save one shovelful out of five. Most of them could save at least one out of ten by the application of reasonable intelligence to firing and furnace maintenance. Why not tack up a sign like this in the boiler room:

"Each scoop of coal is worth a nickel!
Watch your fires! Save the nickels!"

A New Stimulus To Waste Prevention

A FEW days ago there was signed at Locarno, Switzerland, a treaty that will, in all probability, stand as one of the landmarks of history. Apparently the old lineup—the allies versus the central powers—has been shattered by this compact in which France and Germany guarantee a fifty-mile demilitarized zone along the Rhine, the violator of which must face the combined forces of England, Italy and the threatened nation (France or Germany) as the case may be.

This laying aside of wartime animosities signifies more than a desire for peace for its own sake. Wisdom born of necessity will make of Europe a formidable rival in World trade.

To meet this competition America must wage ceaseless war on waste in production and distribution. In this legitimate conflict the conservation of fuel, labor and capital in power and heat production must play an important part. This in turn requires the conservation of the fruits of study and experience. The bits of worth-while information on best practice must be gathered up piece by piece in the four corners of industrial America and made available to all who can use them. Thus only can the whole country move forward most rapidly and with the least waste effort. In this collection and dissemination of useful information the industrial press must play a leading part, backed up by the willing co-operation of the men who do things worth while in industry.

Oil and Water

OIL and water will not mix; oil, being lighter, rises to the top—if it has time. Water should never be allowed to mix with lubricating oil, but usually this desirable condition cannot be realized with steam-driven machines; oil and water are lashed into an emulsion, and the time available is frequently insufficient for separation. Cure must remedy the failure of prevention. The separation of water from oil is absolutely essential to good lubrication. An emulsion of oil and water is not a good enough lubricant for high-speed bearings, and it is exceptionally bad for gears.

The attitude of too many ignorant operators is exemplified by the man who, when criticized for the condition of his oil, said that he had discontinued regular operation of his oil purifying plant because he never got anything out of the oil but water.

It is often stated that it is in the boiler room that the operator may make savings, while in the engine or turbine room, there is little that he can do to affect conditions. This little, however, is important. He can maintain a supply of oil always clean and free from water, and thereby reduce the cost of new oil, often to an astonishing extent, and, what is much more important, reduce depreciation and remove a prolific source of service interruptions.

Why Lose the Waste Heat?

IT IS a most difficult matter to explain the unwillingness of oil-engine plant managements to recover the heat going to waste in the cooling water. Of the over two million horsepower of such engines installed in this country, it is doubtful if waste-heat recoverers are applied to twenty thousand horsepower.

The engine consumes a large amount of air which usually is drawn directly from the engine room. This causes the plant to be cold in winter, for the radiation from the engine is small. To make the place livable, frequently a small heating boiler is connected to radiation coils or a stove used. At the same time the warm jacket water is being put over a cooling tower and the exhaust gases are allowed to carry their heat content into the outer air. Waste-heat boilers are inexpensive

affairs, and certainly it would be profitable to heat the plant through this means.

In industrial establishments hot water is usually needed for washing purposes, but in almost every instance the boiler used for heating is called upon to supply this warm water. Even though the oil engine be too small to heat the building, it would supply sufficient wash water from the jackets and the investment for piping and storage tank would be small.

The recovery of the exhaust heat calls for a somewhat greater investment, but in most instances is fully justified. It is difficult to understand the complacency of engineers in allowing such easy recoverable heat to be wasted. Probably it is because they have not been made to realize the economic value of an effort to recover escaping heat units.

Removing the Barriers to Progress

DEVELOPMENT in the arts is carried forward for a certain period when certain barriers arise that must be removed before further progress can be accomplished. Adoption of the alternating-current system removed the voltage limitations of the direct-current system, and the transformer made possible long-distance transmission and distribution of power electrically. About twenty-five years ago the limit in size of alternating-current generators was being approached, when the adoption of the steam turbine as a prime mover resulted in placing the limit so far in the future that it has not been reached yet. However, limits in strength of materials, ventilation, transportation and shop facilities promise a serious handicap to further increase in size if some improvement in design or operation does not make possible materially increasing the output for a given weight.

One of the limiting factors in an electrical machine is the heating of the windings. The more readily the heat can be removed from the windings and other parts of the machine the greater the load that may be carried. In turbo-alternators air is the medium used in the present systems of forced ventilation, and its ability as a cooling medium is one of the factors that promise to limit the size of these machines. Experiments with hydrogen as a cooling medium give promise of extending the limits in capacity with present designs. The use of this gas as a cooling medium was suggested about ten years ago, but could not be utilized until the development of the closed system of ventilation. What at first appeared to be the most serious objection to using hydrogen; namely, the danger of explosions has been found by experiments to be less serious than at first anticipated. Investigations have shown that as long as the amount of air infiltration is less than thirty-five per cent there is no danger of explosion. Several devices are available that may be used to detect a change in the mixture and give an alarm long before an explosive combination is reached.

Two of the benefits to be gained by using hydrogen for the cooling instead of air in turbo-alternators are, a gain in capacity of about thirty-three per cent and a one per cent improvement in efficiency. The gain in capacity means that machines of one-third greater output than under the present limitations of design can be constructed. Figuring at three-quarters of a cent per kilowatt-hour at the switchboard, one per cent increase in efficiency on a fifty-thousand-kilowatt machine operating at fifty per cent load factor is worth about fifteen thousand dollars a year, and on the one-hundred-thousand-kilowatt unit, the no distant future promises one per cent gain in efficiency, which would be double this amount.

Adding to this the reduction in costs for land, buildings and machines for a given capacity, as well as other advantages to be gained by using hydrogen as a cooling medium, gives promise of removing another barrier in the development of electric-generating equipment. Although all the problems in its use have probably not been solved, reports indicate that developments in this direction have progressed so far that machines using the new cooling medium will be built in the early future.

The Powdered-Coal Engine

FROM the issuing of the original patents on the high-compression oil engine the idea of making use of pulverized coal as fuel for internal-combustion engines has appealed to many inventors. Even Dr. Diesel was attracted by the idea, so it is not surprising to learn that one large manufacturer has constructed an engine to use powdered coal. Although the Low engine, using coke, ran satisfactory tests in England several years ago, this did not introduce the fuel into the cylinder, but burned gas developed in the producer forming part of the head. The present experiments are with an engine in which the coal dust enters the cylinder. Just what success is being obtained is unknown outside the test room, but it would be interesting to learn how the obvious difficulties are being surmounted.

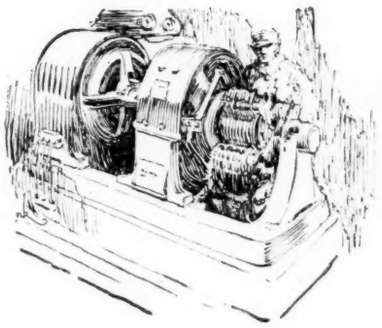
In an oil engine a small amount of ash present in the fuel oil often works havoc with the wearing surfaces. The much greater ash percentage in the best of coals would, under normal conditions, destroy the cylinder in a few hours' time. Before the coal-fired engine can be a commercial success, some method must be discovered by which the ash can be eliminated prior to the introduction into the working cylinder.

A flotation process might serve to separate the ash and combustible, but this would necessitate the after removal of the flotation medium; this does not seem an impossibility. The simple way to circumvent the ash question is to make use of a cylinder that would not be affected by ash. This calls for the discarding of the piston-type of engine and the substitution of an explosive chamber as in the Humphrey pump.

In certain tests with the Humphrey combination of hydraulic pump and internal-combustion engine, using oil as fuel, it was found that the water in the combustion chamber chilled the compression air to a point where auto-ignition was impossible. Conditions would not be the same when using coal dust, as the ash would settle on the surface of the water and form more or less of a non-conducting screen between the water and air charge. Inasmuch as the Humphrey pump can be built in large capacities, it apparently promises possibilities as a pulverized-coal engine.

The atomization of the coal dust should offer no unsurmountable obstacles, for fine atomization is not necessary even in the oil engine, as long as the time element is satisfactory. The production of a suitable unit would go far toward the solving of the mouth-of-mine power problem, for the amount of makeup water would not exceed the capacity of almost any mountain stream.

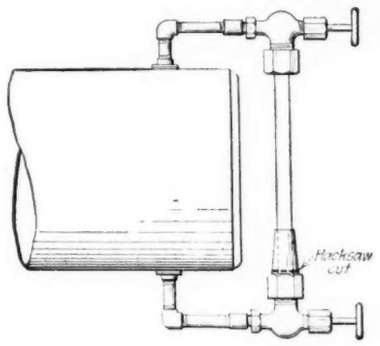
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for September will be announced next month.

How Trouble from Gage-Glass Breaking Was Overcome

The equipment in our plant includes two 15-ton ammonia compressors and a receiving drum fitted with a 24-in. gage glass. Until recently we had trouble from the glass breaking in the lower fitting when tightening up the packing nut. The nut on the lower fitting was



Cutting sleeve off the lower packing nut stopped gage-glass breaking

extended to form a sleeve about 3 in. in length, as shown in the illustration. The threading in the nut was not concentric with the hole in the sleeve, and the nut could not be tightened without risk of breaking the glass. The only way we could use the glass was by changing the packing every now and then.

The glass began leaking some time ago, so I decided, before tightening up the nut, to separate the sleeve from it. I removed the glass and cut the sleeve off with a hacksaw, being careful not to damage the inner shoulder. I then cleaned the glass, oiled the packing and placed the sleeve on top of the nut. We can now tighten the nut without fear of breaking the glass.

Pana, Ill. J. H. GILMAN.

Counterboring Ends of Pump Liners Greatly Increases Length of Service

If you have ever pumped casing-head gasoline, with a gravity of from 75 up, you know something of the trouble in keeping pump liners and packing rings in shape.

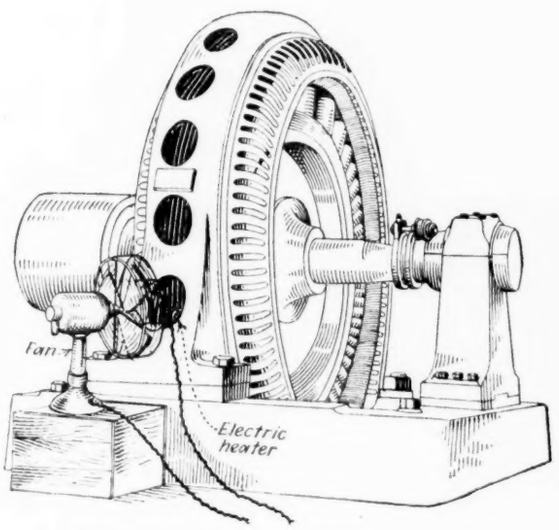
We have a pump that has been used for pumping gasoline on twenty-four-hour service, for more than four years. At first we had to renew the liners frequently, but we finally overcame this trouble by counterboring the new liners ½ in. larger, back the distance from the end of the piston stroke to the end of the liner. This counterbore permits us to slip in larger size packing rings, as the liners wear. In our case we use the medium-hard hydraulic solid rings and have them made up in five sizes, advancing in thirty-seconds of an inch. This has increased the life of the liners about four times. It requires but little time to repack the pump, while it takes several hours to put in a new liner, not to mention the expense of the liners.

Desdemona, Tex. C. E. LOVE.

Putting Flooded Motors into Service Quickly

We are all looking for short cuts and easier ways to get work done. This is especially true when machines are out of service, so it is a duty to pass on new schemes.

A pair of high-voltage motors were accidentally flooded with water that came several inches over the



Fan blows heated air through motor windings

lower coils. The trouble man was on the job before the water was all out of the motor room and took stock of local resources. Several fans and bathroom heaters were located and put to work at once. In fact the drying was started before the water was all pumped out.

Two of the heaters were placed in each side of the frame, as shown in the figure, and the fans placed so they would drive air across the heaters and down under the laminations. The streams of air from the two sets of fans met midway under the center of the armature and came up through the air ducts and around and through the ends of the windings. This warm air dried the coils and also the bottom field coils. The resistance to ground jumped from 200,000 ohms to 40 megohms over night, and the machines were placed in service.

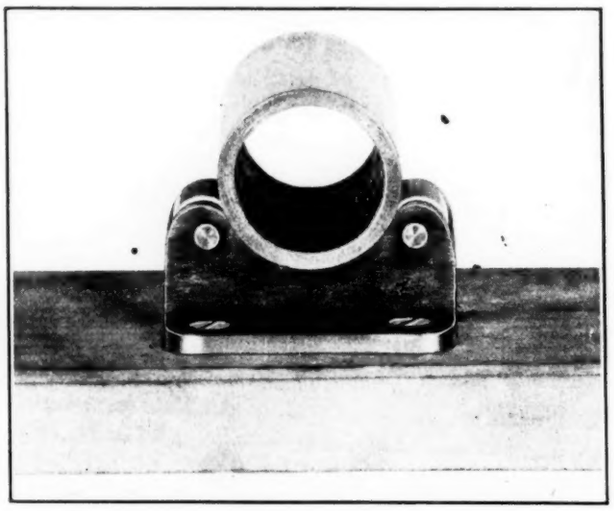
N. L. REA,
Schenectady, N. Y. General Electric Co.

Roller Supports Facilitate Construction of Pipe Line

Some time ago it was decided to lay on the surface of the ground at our mine an 8-in. pipe line to carry compressed air from one shaft to another. The lengths of pipe were connected up with couplings, and the total length of the line was approximately 3,000 feet.

Our usual method of doing this work was to support each length of pipe on two heavy wood planks blocked up to the proper height and having a ½x3-in. strip of iron laid on them to reduce the friction. Then by turning the length of pipe with the tongs and holding bars against it to keep it in place, the connections would be made. With this method of doing the work the pipe would tend to get out of alignment with the line that it was to be connected with, making it difficult to get the pipe thread to take hold.

To obviate the difficulty of keeping the pipe in alignment, we made two sets of rollers as shown in the illustration. A set is placed at each end of the length of



Model of rollers used to support lengths of pipe when connecting to line

pipe that is about to be connected and raised or lowered as may be necessary. The pipe now has no tendency to get out of alignment, and the friction is greatly reduced when tightening up the pipe.

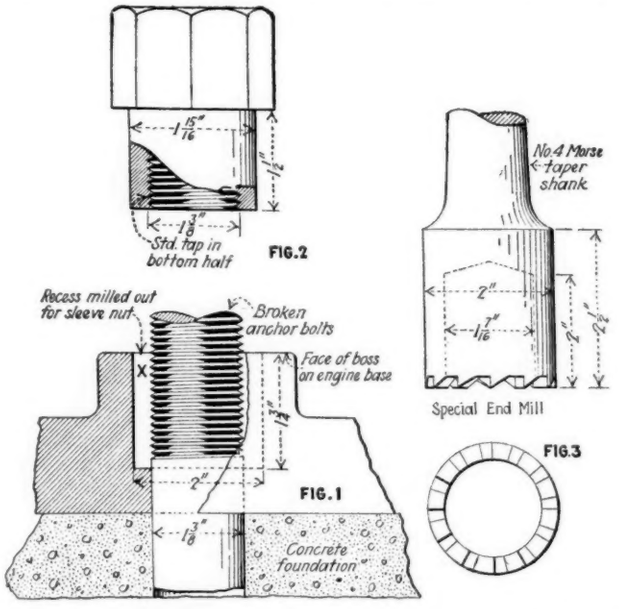
The model shown herewith is one-sixth of the full-sized roller, which is suitable for handling pipe from 6 to 12 in. in diameter.

THOMAS PASCOE.
Norway, Mich.

Securing the Engine on the Foundation by the Use of Extension Nuts

Upon taking charge of a certain power plant some years ago, I was surprised to find some of the engines running with several of the anchor bolts broken off about flush with the top of the holes in the bedplate. One engine in particular, running at 250 r.p.m., driving an alternator, had only one bolt left unbroken on the cylinder end of the horizontal bedplate.

This engine was required on the line twenty-four hours a day for the winter months and was apparently



Figs. 1 to 3—Recess in bedplate with type of hollow mill and extension nut used

held in place only by virtue of the 8-in. steam pipe, for with every sudden increase in the load, it would badly rock on its foundation.

An examination was first made of the broken bolts to see if repairs were possible without taking the engine off the line. By cleaning the grout away from the top of the bolts with a hacksaw blade, it was found that three out of the four broken ones had still from 1 to 1½ in. of thread left, the fourth having only ⅝ in. of thread. It was then decided to bore out the holes in the bedplate as in Fig. 1, and make special extension sleeve nuts to use on the broken bolts.

The hollow end-mill, shown in Fig. 3, was made up at once in the machine shop out of annealed tool steel. A No. 4 Morse taper shank was turned on the end to fit the air drill. We did not wait to cut flutes in the body of the mill for the borings, but used the air hose periodically to blow the hole clean.

The boring rig was set up first on the bolt needed most on the end of the bedplate, and the recess shown at *X*, Fig. 1, bored out in an hour. The special nut, Fig. 2, was then screwed on, there being ⅛ in. clearance left between the diameter of the sleeve and the hole.

The result of this end bolt being back on the job again was at once apparent in the running of the engine, and no time was lost in making similar repairs to the other broken bolts. Four years later this engine was still fast on its foundation with the special nuts in use.

After a little investigation I came to the conclusion that the breakage of the bolts was due to the following reasons:

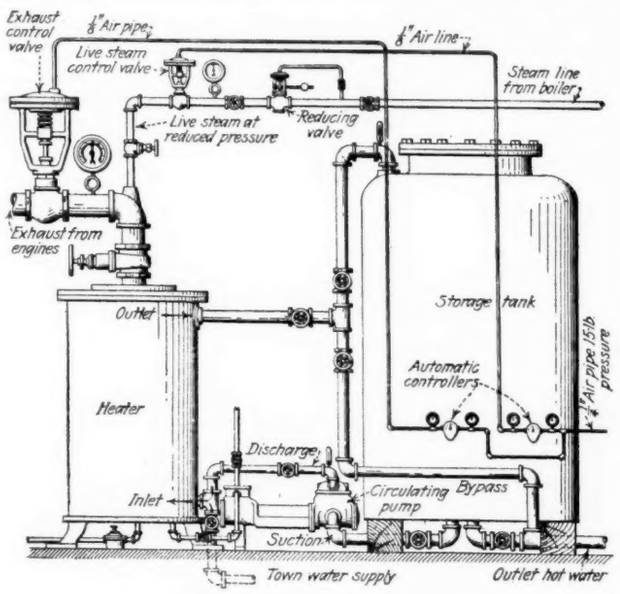
Either the first one to break had been tightened up sufficiently to start a fracture at the bottom of the thread or else had been screwed up so much harder than the adjacent ones that it took practically all the stress on that end of the engine bed up to the time of its breakage; after that the others would go in turn owing to the increased stress put on them.

An examination with a good glass of the fractured ends of the bolts on this particular engine showed no flaws in the steel except an apparent crack on one side of the bolt, which I found by inquiry to have been the first one to let go. On some of the other engines a poor grade of iron had been used for the bolts, and several of the nuts, although faced and nicely finished, did not come down fairly on the bedplate, and the latter had to be chipped and filed before the nuts could be given a proper bearing. J. A. CARRUTHERS.

Lethbridge, Alberta, Canada.

Controlling Exhaust and Live Steam to Heater

A few years ago I was employed in a plant that used a large amount of hot water, exhaust steam being used to heat it and for other process work. We had only one 800-gal. storage tank and a heater with a circulating pump. There were several tubs that held about 1,000 gal. each, so the storage tank was much too small, for



Arrangement of live and exhaust steam lines equipped with control valves

when filling a tub the tank was soon emptied of hot water. The heater did not have sufficient capacity to heat the water with exhaust steam, if large quantities of hot water were being used. Then frequently a partial vacuum would form in the heater, causing some of the exhaust steam going to process to be drawn into the heater, thus seriously curtailing the process work.

The company did not see its way clear to buying a large storage tank, so we had to do the best we could with what we had. First, we piped a line from the steam main to the heater and put in a reducing valve set to close at slightly less than what the back-pressure valve on the engine opened at. Then, when drawing off the water, the pressure would drop and the valve would admit live steam to the heater. This helped considerable and gave sufficient hot water, but still robbed the process of steam, and the call on the boiler for steam was excessive. As we had a couple of old thermostatic control valves on hand, we put one in the live steam line on the low-pressure side of the reducing valve. This valve was set to close when the water reached 145 deg. and would open and admit live steam at reduced pressure when the temperature dropped to 140 deg. As it was not necessary that the temperature of water go above 180 deg., we fitted up the other thermostatic valve to shut off the exhaust steam when the temperature of the water reached this point.

This arrangement greatly improved our operating conditions and made a considerable reduction in the fuel bill. G. M. PHINNEY.

Needham Heights, Mass.

Partial Vacuum in Heater Caused Pump to Pound

We recently experienced some trouble with our feed-water system which could so readily occur in any plant with similar equipment that I believe the subject will be of general interest to *Power* readers.

Our three engines, one 500-hp. Corliss and two 100-hp. high-speed slide-valve engines, exhaust into a common header, which in turn terminates in an open feed-water heater of the "straight through" type. Process steam is also drawn from this exhaust header for various drying and heating purposes. The 5-in. line to the beater room, from which branches are run to the stock heaters, is fitted with a back-pressure valve to prevent the drawing of too much steam from the header. Feed water is pumped to the boilers from the heater with a motor-driven triplex pump.

Receiving a "hurry up" call from the boiler-room foreman one morning recently, I hastened out to find this pump pounding so badly that it had to be shut down. After standing a few minutes, it was again started and ran for some time before the pounding recurred. I noticed that as soon as the pounding began, the water in the heater gage glass rose and fell regularly, also that the float valve admitting the makeup water opened and closed. Holding the float valve closed stopped the pound after a few minutes, but when opened again the trouble was re-established. I then came to the following conclusions:

For some reason the quantity of steam entering the heater would decrease sharply, leaving the storage space full of water at about 212 deg. F. The cold makeup water would then condense whatever steam there was in the heater, creating a partial vacuum, which tended to draw the water in the suction line away from the pump or cause it to flash into steam. This gave an intermittent flow to the pump, causing it to pound. Upon inspecting all the branch feeders from the exhaust line, I found the beater room back-pressure valve wide open. Closing this valve somewhat, stopped the trouble.

Apparently, the steam entered the heater in slugs, as there appeared to be a rather slow periodic rise and fall in the water level in the heater, with a corresponding opening and closing of the float valve.

Little Falls, N. Y. ROBERT N. OTTMAN.

Comments from Readers

Quick Repair of an Eight-Inch Steam Main

In reading the article entitled "Quick Repair of an Eight-Inch Steam Main," in the Aug. 25 issue, I wondered why the author did not go one step farther in eliminating joints by cutting out completely the section of pipe about 3 or 4 ft. long containing the flanged joint and welding in with the oxyacetylene torch a piece of straight pipe, in the same manner as he made the one welded connection.

We have done this in a couple of cases in our plant recently with satisfactory results. It not only eliminates the ever-present source of leaks in the threaded joint and gasket, but also makes a much neater-looking job when covered. CHARLES C. COBB, JR.

Kewanee, Ill.

Balancing a High-Speed Fan

For drawing the hot gases from the furnace through a revolving drier, a belt-driven fan was erected on the steelwork of the second floor of our plant.

When the fan was brought up to speed for the first time, it vibrated badly, a condition not helped by the nature of its foundation. It was decided that something better than a static balance was needed, considering the high speed at which it had to run.

The "cut and try" method of giving the fan a running balance was agreed upon. Each of the fan blades was numbered and two $\frac{1}{2}$-in. diameter holes were drilled near the top of each fan blade, for attaching the balancing weights.

The weights consisted of strips of steel plate about 3 in. wide and about 9 in. long and from $\frac{1}{32}$ to $\frac{1}{8}$ in. in thickness. The plates were drilled to match the holes in the tips of the fan blades. We began by bolting a plate $\frac{1}{16}$ in. thick to the No. 1 blade, then the fan was brought up to speed and the amount of the vibration noted. The same was done for the other three blades.

Having found the blade that needed the additional weight to improve the balance, more and less weight was added to it until the least vibration was noted. Then a single plate of the same weight, width and length as the balance test weights was riveted on the blade. Sometimes it is necessary to attach the balancing weights to two adjacent blades to get the best results. E. J. JORDAN.

Long Beach, Calif.

Scientific Engine Selection

In the Sept. 22 issue Egbert Douglas contributes an interesting and instructive article on scientific engine selection. However, he has not carried his calculations far enough. He arrives at the conclusion that a motor-driven air compressor will deliver 0.599 air horsepower for each indicated horsepower at the main steam-engine cylinder, and that a steam-driven air compressor will deliver 0.85 hp. for each indicated horsepower at the steam cylinder. In other words, with a motor-driven compressor, 1 hp. at the air end requires 1.67 i.hp. on the prime mover, and with a steam-driven compressor, 1 hp. at the air end requires 1.176 i.hp. in the steam end.

This is all right as far as it goes, but if we assume the prime mover to be a non-condensing unaflow engine having a steam rate of 20 lb. of steam per indicated horsepower and the compressor to have a steam rate of 40 lb. per indicated horsepower, which would not be at all unusual, we find that for the motor-driven compressor, one air horsepower requires 33 lb. of steam per hour and for the steam compressor one air horsepower requires 47 lb. per hour.

If we assume the prime mover to be a condensing unaflow steam engine having a steam rate of 15 lb. per indicated horsepower-hour, the motor compressor would require only 25 lb. of steam per air horsepower as against 47 lb. for the steam compressor.

This same line of reasoning can be applied to any of the plant auxiliaries, such as boiler-feed pumps, blowers, etc. Of course, if the exhaust steam from steam-operated auxiliaries can all be used, the situation is entirely different.

The point that I wanted to bring out was that in making comparisons such as Mr. Douglas makes, we should take into consideration the steam rates of the prime movers and the proposed steam-operated auxiliaries before arriving at definite conclusions.

St. Paul, Minn. C. J. SNOW.

Auxiliary Exhaust Valves on Unaflow Engines

In Robert Cramer's discussion on "Unaflow vs. Compound Duoflow Engines," some months ago,* he makes the deduction that, while the unaflow engine shows better economy than a compound Corliss engine under the usual range of loads, it is not so economical as the compound engine for the particular load for which the compound engine was designed, usually around full load.

This statement may be true if the comparison is made between the economy of a properly designed compound engine having valves that will not become leaky owing to wear, and that of an improperly designed unaflow engine; but the statement, I believe, does not hold true if the comparison is made with a properly designed unaflow having auxiliary exhaust valves properly situated, which do not leak.

The curve reproduced in Fig. 1 shows the results of a witnessed test on a 21x24-in. Universal unaflow engine supplied with saturated steam at 155½ lb. pressure and exhausting to atmosphere. The accuracy of this test can be substantiated by affidavits of those conducting it. This engine was of standard design throughout, and its performance has been duplicated by other engines of the same kind.

*See page 263, Feb. 17, 1925, issue.

I have never seen a report of a carefully conducted test on a compound engine that showed as good results at the best load point as this engine showed at all loads from one-half to full. By "carefully conducted tests" I mean where a surface condenser was used to condense the exhaust steam at atmospheric pressure, which

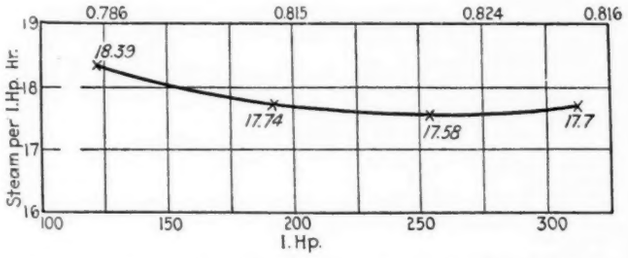


Fig. 1—Curve showing steam rate of unaflow engine at different loads

method of testing is naturally more accurate than where the water is weighed before being fed to the boiler.

Another point that should be considered is the poorer mechanical efficiency of a cross-compound engine having eight valves operating under unbalanced conditions; and, in the case of the releasing-gear type, having also four dashpots, as compared with a single-cylinder unaflow engine with nearly balanced poppet valves.

Mr. Cramer recites the well-known reason why unaflow engine builders are adopting auxiliary exhaust valves for non-condensing operation, namely, to reduce the loss occasioned by the necessarily large clearances which must be employed in non-condensing unaflow engines having no auxiliary exhaust valves. He prophesies that the adoption of auxiliary exhaust valves will probably become universal.

The auxiliary exhaust valves must be located either at the end of the working cylinder or at some distance therefrom, but the end location is not logical from the viewpoint of engine economy for the reason, as shown in an article by the writer in *Power* for Aug. 29, 1922, that from one-quarter to full load an average of 67 per cent of the exhaust steam issues from the end ports, which

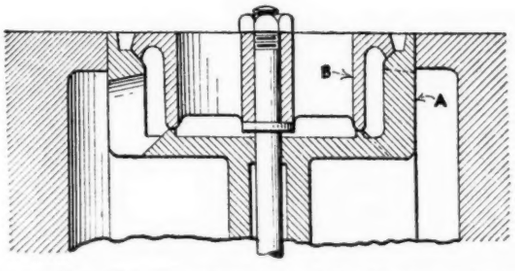


Fig. 2—General arrangement of double-seated poppet valve

steam of course cools the steam-heated heads and that part of the cylinder barrel that has the highest temperature, making the engine more counterflow than unaflow.

Another reason for not placing the auxiliary exhaust valves at the end of the stroke is because the entire surface area of the inside of this valve comes in direct contact with the hot admission steam and, owing to the thin section of the walls of this valve and their contact with the exhaust cage and other exhaust parts, the heat conductivity will be high. One of the most important considerations in maintaining the unaflow economy is to have the incoming steam impinge only on walls that are heated by jacket steam, thus eliminating initial condensation.

If a solid double-seated poppet valve will leak with varying steam temperatures when used as an admission valve, the same type of valve when used in the exhaust will be even more susceptible to leakage because it never can be ground tight for any certain temperature or pressure condition. Referring to Fig. 2, illustrating a double-seat auxiliary exhaust poppet valve placed at the end of a unaflow cylinder, it will be seen that the bridges *A* connecting the upper and lower seats in the valve cage, are subjected only to the exhaust temperature, which, in the auxiliary port of a unaflow engine, has practically no temperature or pressure change. The interior of the valve itself, *B*, however, is subjected to the greatest temperature changes obtaining in the engine. One instant it is heated by the boiler steam during the period of admission; the next instant it is cooled by the exhaust steam that is being swept through it.

The two seats on the valve itself and the two corresponding seats on the cage must be in actual contact

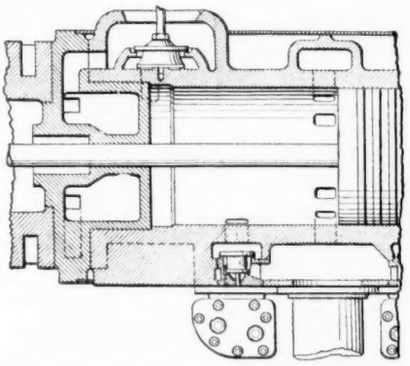


Fig. 3—Double-seated exhaust poppet valve placed between central exhaust ports and end of cylinder

with each other in order to be steamtight, and such a valve can never be ground steamtight for these constantly changing conditions that influence the expansion and contraction of the valve itself, because these conditions cannot be duplicated at the time of grinding. If the valve is ground to the cage cold, the operating conditions have not been duplicated in the grinding and the valve will leak. The same is true if both are ground hot. It needs no explanation to show that it would be impossible to grind the valve tight with such continuously changing temperatures while the cage containing the seats had a constant temperature.

Leakage would result from the adoption of solid double-seated poppet exhaust valves, even though placed in the cylinder between the central exhaust ports and the end, as in Fig. 3. The leakage would not be so great, however, because the interior of the valve would not be subjected to such a wide range of temperature and pressure, and during the early part of the expansion stroke the valve would be under no pressure at all. This would considerably lessen the leakage for the reason that when the valve is exposed the pressure in the cylinder has been greatly reduced.

The locating of the exhaust valve between the end of the cylinder and the central exhaust ports allows the adoption of an entirely different type of exhaust valve

and one that will be steamtight because such a location means that a single-beat or "mushroom" type of valve can be employed, as shown in Fig. 4. In this location the valve can be operated under practically no unbalanced pressure conditions. The central exhaust ports have been uncovered by the piston, and there is exhaust pressure on both sides of the valve before it begins to open. The exhaust valve remains open on the return stroke after the piston has crossed the auxiliary port, and it therefore closes under balanced conditions. This also allows the employment of a simple and light operating gear. Furthermore, the valve requires a minimum

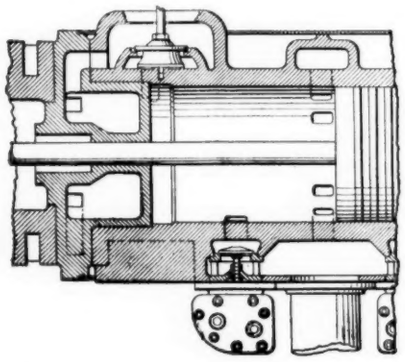


Fig. 4—Single-beat auxiliary exhaust valve located between center and end of cylinder

of clearance. This single-beat or "mushroom" type of poppet valve cannot, however, be employed successfully if located at the end of the cylinder. A typical four-valve unaflow indicator diagram *A* is shown in Fig. 5, with the stroke plotted at the bottom in per cent and with steam pressures plotted at the left, using as an illustration 150-lb. throttle pressure with atmospheric exhaust.

Superimposed on this diagram is a piston-velocity diagram for a 32-in. stroke engine operating at 150 r.p.m. The values of the piston velocities are indicated in the right-hand column. Although the average piston speed is only 800 ft. per min., it will be noted that speeds considerably in excess of this are obtained for approximately 75 per cent of the stroke, reaching a maximum of 1,250 ft. per min. in midstroke. This, of course, is a typical curve for any reciprocating engine.

Above the diagram is shown the location of the auxiliary exhaust port *B*, used on Universal unaflow engines, which, on this size engine, is 4½ in. long, having its nearest edge approximately 20 per cent of the stroke away from the end of the cylinder.

At the top are plotted three valve-lift diagrams showing the amount of exhaust-valve opening at any point of the stroke. The upper curve *C* indicates the typical valve lift on the engine having auxiliary exhaust ports between the end of the cylinder and the central exhaust ports. It will be seen that the valve starts to open at the beginning of the return stroke and reaches its maximum lift of 1½ in. at midstroke and closes slightly after the piston has covered the auxiliary exhaust ports. This gives the maximum valve opening during the time the piston is displacing steam in the cylinder at the highest rate. It should also be noted that when the piston is covering the auxiliary port, its speed is approximately 1,150 ft. per min., requiring only 0.022 seconds time to cross the port, which gives a quick closing of the port, after which, of course, the pressure in the cylinder rises, as shown by the compression line of the indicator diagram. The valve, however, does not seat until the piston has reached the end of its stroke.

Were a single-beat valve *F* located at the end of the cylinder, the timing would have to be obtained by the closing of the valve and a valve so adjusted would give lifts as indicated by the mid curve *D*. It would be impracticable to close a single-beat valve within a time limit much less than that indicated (0.053 sec.) when the fact is considered that the valve must lift 1½ in. This means, therefore, that before the valve has fully seated, the pressure in the cylinder has built up to approximately 48 lb. and that the instant just before seating this full pressure bears over the top of the valve, whereas only atmospheric pressure exists below the valve. This pressure figured over an 8-in. valve with over 50 sq.in. area would give a load of some 2,400 lb., which must be supported by the cams up to the instant of the actual seating of the valve.

It will, therefore, be readily understood that a single-beat valve cannot be used, as it would be impractical to impose such an extreme load on any cam mechanism that could be practically built into the engine. Furthermore, a great deal of wiredrawing through the valve would take place, which, with the high moisture in the exhaust steam, would probably result in rapidly cutting the seats. For this reason, if a poppet exhaust valve is to be used and located at the end of the cylinder, it is necessary to provide one of the double-beat balanced type.

The typical valve-lift curve for the double-beat valve located at the end of the cylinder is shown at *E*, with

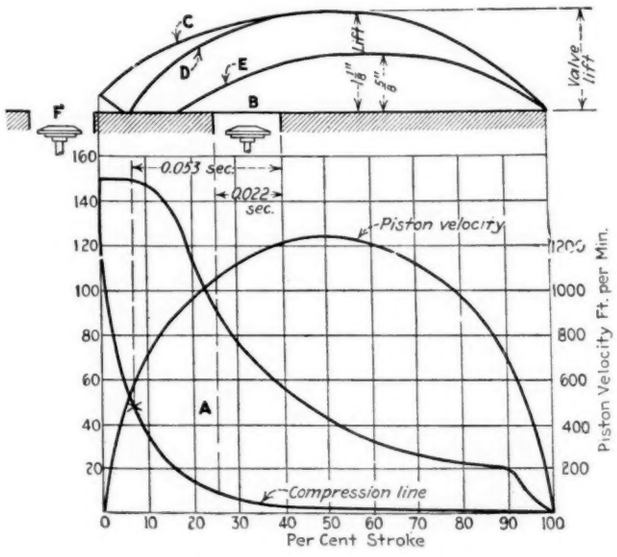


Fig. 5—Piston-velocity and valve-lift diagrams superimposed on a typical four-valve unaflow engine diagram

⅜-in. valve lift, the lift being less on account of the valve having two seats. This type of valve is, however, subject to leakage and is illogically located, as above explained. The proper location is some distance from the end of the cylinder, which minimizes the heat transfer, and the balanced conditions under which a valve so placed will operate allows the use of a single-beat valve which is steamtight under all conditions.

Erie, Pa. A. D. SKINNER.

Questions and Answers

Conducted by

Franklin Van Winkle

Running Throttle-Governed Slide Valve Engine with Light Load

If the load on a 100-hp. slide-valve engine with throttling governor running to full capacity was to be reduced to 30 hp., what would be the best alteration of the valve setting if the boiler pressure and engine speed were to be retained? *G. R.*

The simplest adjustment would be to advance the eccentric to obtain earlier cutoff and earlier compression. This should not be done, however, to the extent of raising the compression higher than the initial steam-chest pressure with the lightest load or to increase the lead so much as to give trouble in starting the engine.

Use of Muriatic Acid for Cleaning Scale from Water Jacket of Diesel Engine

What amount of muriatic acid should be used to dissolve scale from the water jacket of a Diesel engine? *A. N.*

The water jacket should be filled with a 25 per cent solution of muriatic acid—that is, one part muriatic acid to three parts water—which should be left standing in the jacket until the escape of gas bubbles has ceased. The jacket then should be drained and immediately washed out with clean water and refilled with a solution of 1 lb. of carbonate of soda to 5 gal. of clean water, which should be allowed to stand for about the same length of time given to the acid solution, after which the jacket should again be washed out clean.

Determining Average Height of Indicator Diagram

What is a good method of determining the average height of a steam-engine indicator diagram without use of a planimeter? *J. G. S.*

The commonest error made in measurement of ordinates results from making imperfect scale readings and summation of measurements of the middle ordinates that are to be measured between the equally spaced ordinates. The most accurate method is to take a strip of paper having a straight edge and beginning with a zero point located on the edge of the strip near one end, transfer a summation of the heights along the edge of the paper strip. Then use a two-foot rule or scale that is long enough to make a single measurement of this summation, and to obtain the average height, divide the summation by the number of middle ordinates thus measured. When the number of ordinates taken is ten, the average is quickly found by pointing off one decimal place from the number of whole inches of the summation. In transferring the separate heights to the strip of paper by lead pencil marks, it only needs to be remembered that individual measurements should be taken from center to center of the pencil marks made along the edge of the paper and not between the marks, and then the transfer and summation can be performed with practically as great accuracy as though made with a draftsman's sharp-pointed pencil. Besides simplicity and accuracy, this method of obtaining the average height of ordinates has the advantages of a graphical record of measurements that is readily checked.

Starting Engine from Top or Bottom Quarter

Will a single-eccentric engine start on the top quarter but not on the bottom quarter? *W. P. S.*

The engine cannot be started from either quarter unless enough steam is admitted to overcome the compression and lead of the reverse stroke and carry the crank past the dead center. But when the valves are set the same for both ends of the cylinder, there is no reason why a start should not be made as easily from the same fraction of stroke below as above dead center, except for the relatively small assistance from weight of the crank and connecting rod when starting in the top quarter as compared with the resistance from those weights when raising them from the bottom quarter.

Degree of Vacuum Shown by Indicator Diagrams

How can the number of inches of vacuum be computed from an indicator diagram of a condensing engine? *W. L. G.*

The term "inches of vacuum" is used to designate intensity of pressure expressed in inches of mercury column pressure less than the assumed intensity of pressure exerted by the atmosphere. One inch of a mercury column exerts a pressure of 0.491 lb. per sq.in. Therefore the inches of vacuum shown at any point of an indicator diagram would be found by multiplying the distance in inches that the point in consideration is below the atmospheric line, by the scale of the indicator spring and dividing the product by 0.491.

The number of inches of vacuum thus shown for any point on the diagram, or the average vacuum shown for the whole exhaust stroke, must be less than the inches of vacuum in the condenser, on account of higher temperature of the engine cylinder and the throttling effect of exhaust passages and connections to the condenser.

Required Size for Staybolts

How is computation made of the size of a screwed and riveted staybolt for the water leg of a boiler where the staybolts are pitched 8 in. x 8 in.? *W. P. S.*

The size required for a staybolt is figured according to the working pressure and area supported by the staybolt, allowable strength of material of the stay-

bolt and size giving the requisite cross-sectional area at the bottom of screw threads. Where the pitch is 8 in. x 8 in., neglecting the reduction of area from presence of the staybolts, the area to be supported would be 64 sq.in. and load per staybolt for an allowable pressure of 100 lb. per sq.in. would be 6,400 lb. Having 12 standard screw threads per inch, and allowing a load stress of 7,500 lb. per sq.in. of cross-sectional area would require a net cross-section at the bottom of the threads of 6,400 ÷ 7,500 = 0.853 sq.in. which is most nearly covered by a commercial size of staybolt with 12 V screw threads per in., 1⅞ in. outside dia., giving diameter at bottom of thread 1.0432 in., net cross-sectional area at bottom of thread 0.855 and allowable load of 0.855 × 7,500 = 6,412 lb.

Pipe Coil for Brine Tank

How many B.t.u. will one square foot of iron pipe transmit? In a brine tank 36x26x8 ft., with two 150-ton machines running on this tank, how many feet of 1¼-in. pipe should there be in this to do this work with a condenser pressure of 150 lb., a suction pressure of 6 lb., and the brine leaving the tank at 5 deg. F.? What is the specific heat of chloride of calcium having specific gravity of 1.261? *W. B.*

For a tank of this size in all probability not over 150 tons of ice will be made per 24 hours. This would call for the removal of 144 B.t.u. in the freezing of each pound of water plus the cooling of the water to 32 deg. plus the aftercooling of the ice to its actual tank temperature. This may be assumed to total 170 B.t.u. per lb., or for the 150 tons of approximately 2,100,000 B.t.u. per hour. With an ammonia pressure of 6 lb. gage the evaporating temperature would be 14 deg. F., and as the brine is at 5 deg. F. the temperature difference is 9 deg. F.

A square foot of pipe surface will transmit from 100 to 500 B.t.u. per hour per degree temperature difference, depending upon the velocity, etc. Assume 200 B.t.u. for the tank in question, the square feet of pipe surface becomes

$$2{,}100{,}000 \div (200 \times 9) = 1{,}166 \text{ sq.ft.}$$

The internal area per inch length of a 1¼-in. pipe is 4.33 sq.in. and the quantity of pipe needed is $1{,}166 \times \frac{12}{4.33} = 3{,}231$ lin.ft. of 1¼-in. pipe. The specific heat of calcium chloride, having specific gravity of 1.261, will be approximately 0.7.

Riveting of Girth Seams

Why are the circumferential seams of horizontal return-tubular boilers made single-riveted and with small pitch of rivets? *W. H.*

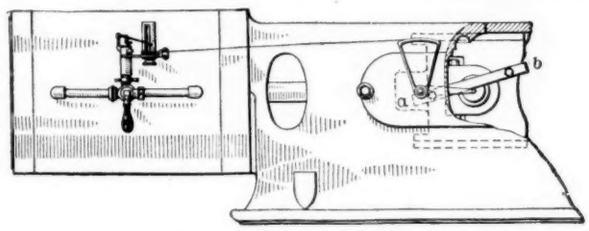
Aside from the assistance rendered by the hold of the tubes, and also by through stays when used, the circumferential joint of a round shell is called upon to resist only half as much stress for a given length of joint and given internal pressure as the stress that must be resisted by the same length of a longitudinal joint, and therefore single riveting is sufficient.

However, when seams are directly exposed to the fire, the joint always should be single-riveted, as this form presents a minimum amount of metal to the destructive action of the fire. The overlapping of the plate should be as small as consistent with the strength and preferably with seams lapping away from the fire so it will be less likely to impair the calking. The outer plate of a girth seam where exposed to the fire is more or less overheated and, to counteract the tendency of the outer plate to expand away from the inner plate, the distance between rivet holes should be made smaller than on seams that are directly exposed to the fire. The space between rivet holes regarded as safe is 1¼ in. for plates ¼ and ⅜ in. thick; 1⅝ in. for plates ⅝ in. thick; and 1⅞ in. when the plates are ⅞ in.; ½ in. or ⅝ in. thick.

Guide-Bar Reducing Motion

What is the arrangement of an indicator reducing motion for a horizontal high-speed engine in which the brumbo pulley receives motion from a rocker arm that is guided by a bar on the side of the engine crosshead? *J. N. W.*

The general arrangement of a reducing motion of this kind is shown in the illustration. An inclined guide bar, consisting of a strip of steel *ab* about ½ in. thick, is mounted on the side of the crosshead by setscrews which pass through the strip and separators for holding the inner side of the strip about 1 in. clear of the crosshead pin. A brumbo pulley or sector with grooved face for the indicator cord, is fastened to a shaft that extends through the engine frame. The inner end of this shaft carries a rocker arm fitted



Guide-bar reducing motion

with a small crankpin whose side is brought into contact with the lower edge of the inclined strip *ab* by tension of the indicator card.

When the engine crosshead moves back and forth, the rocker arm travels up and down, making the same angular oscillation as the brumbo sector. With the lower edge of the strip *ab* straight, the vertical displacement of the pin in the end of the rocker arm bears nearly a constant relation to the crosshead travel; but, as the rocker pin travels in an arc of a circle, the travel of the indicator cord does not bear a constant relation to the travel of the crosshead, with the result that, for actual cutoff at less than one-half stroke, the diagrams will show later cutoff and earlier release than the actual. The error may be regarded as negligible for most purposes, but where greatest accuracy in interpretation of diagrams is required, as in testing the economy of an engine, the diagrams should be corrected from actual tests of the reducing motion; or by laying out the reducing motion on a drawing board, it can be determined how the lower edge of the guiding strip *ab* is to be modified from a straight line to obtain, for the indicator cord, a travel that will bear the same ratio to the crosshead travel for all fractions of the stroke.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications, and for the inquiries to receive attention.—Editor.]

New and Improved Equipment

American Machine & Foundry Rotary Pump

The illustrations show a type of rotary pump brought out recently by the American Machine & Foundry Co., Brooklyn, N. Y. The pump is designed for high speed and is claimed to be equally adapted to pressure or vacuum work.

A general view of a 5-gal. per min. pump direct-connected to a high-speed motor is shown in Fig. 1. Fig. 3 is a schematic diagram of the operating principle. The rotor, which is keyed to the shaft, is a plain drum, like the armature of a motor. Upon the surface of this drum is cut a wide helical groove, across which lies a vane, or dam. The drum is made of high-grade bronze and the vane of light metal or of lignum-vitæ.

As the rotor moves, the vane, which is retained in a slot in the liner, reciprocates under the camming action of the helical groove. The vane acts simply as a stop between the suction and discharge ports.

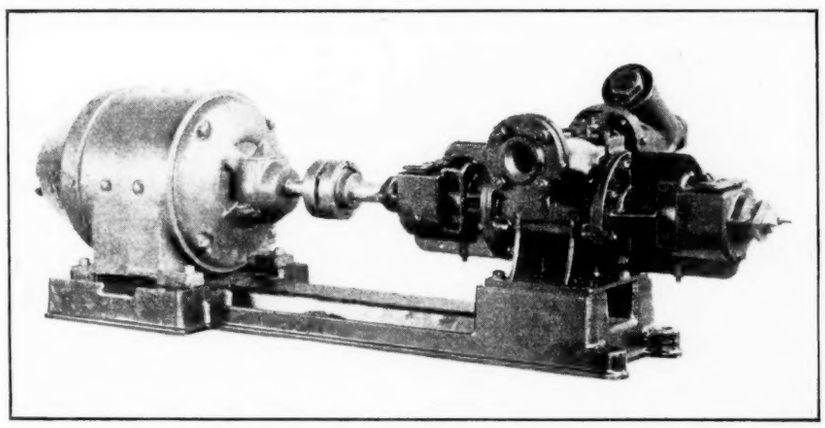


Fig. 1—View of rotary pump direct-connected to motor

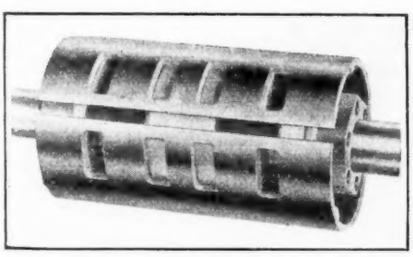


Fig. 2—Rotor and liner assembly

Fig. 2 shows an assembly of the double rotors of this type of pump, with the lining sleeve in place over the rotors and the two vanes in position in the slot of the liner. The liner is keyed in place within the pump housing.

In operation the cam surfaces of the rotor work like pistons in a reciprocating pump, suction occurring during the half-revolution of the rotor when the cam surface recedes from the flat surface of the partition, and discharge occurring during the half-revolution when the cam surface again approaches the partition surface. As the suction and discharge forces in each section of the pump are equal at all times, there is practically no end thrust on the shaft.

The ports of the pump are symmetrically spaced with respect to the vanes, and the pump may consequently be operated equally well in either direction of rotation without physical change.

This type of pump is now being made in capacities from 5 gal. per min (½-in. size) to 125 gal. per min. (2½-in. size) ratings.

Manual-Type Contactor with Blowout Coils

The manually operated contactor recently placed on the market by the General Electric Co. is a new motor-circuit switch for disconnecting both motor and control from the line under practically all conditions except a dead short-circuit. It consists of contact elements mounted on an insulated shaft and connected through a snap-action mechanism to the operating handle on the outside of a sheet-steel inclosing case as shown in the figure. The contactors are equipped with blowout coils, similar to that used on magnet operated type switches, which greatly reduce the destructive effect of the arc when the circuit is opened.

Switch with cover removed

Both the inclosing case and handle can be locked in the open position, thus preventing unauthorized persons from

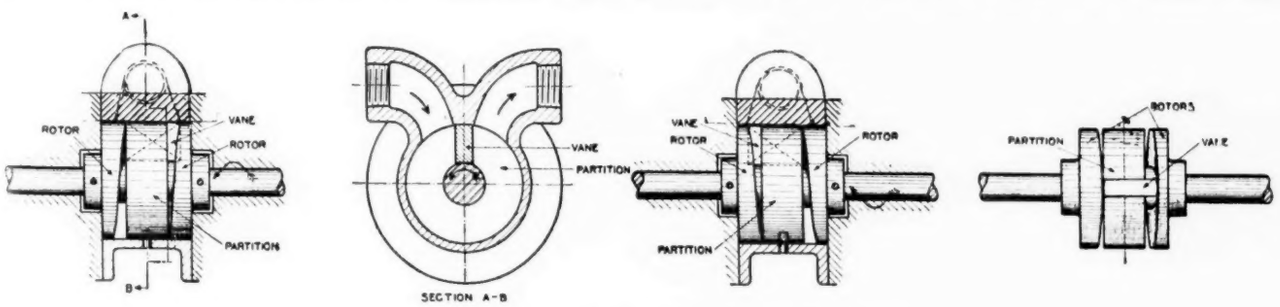


Fig. 3—Schematic diagram of the operating principle

closing the switch. No provision is made for locking the handle in the closed position, since the contactor will open the load with full safety to the operator. Silver contact tips are used on all sizes with the exception of the 50-ampere, thus cutting down the contact resistance. The new contactor is made in four sizes: 50 amperes 3 poles; 80 amperes 2, 3 and 4 poles; 150 amperes 2, 3 and 4 poles, and 300 amperes 2 and 3 poles.

Advance Non-Sifting Stoker

A stoker for burning low grades of coal, and particularly the low-volatile high-moisture lignites, has been designed and tried out in the lignite field by the Advance Machinery & Supply Co., of Denver, Colo. An inclined grate with horizontal air passages to prevent

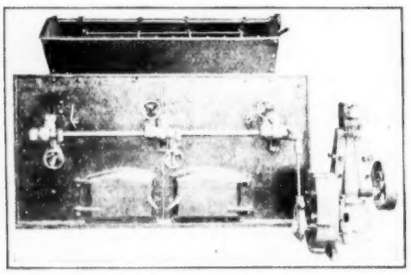


Fig. 1—Front view of stoker

sifting and reciprocating grate bars to cut and slice the fuel bed continuously to prevent the formation of large clinkers and to carry the fuel forward, are the features of the new stoker. The general construction will be evident from Fig. 1, a front view of the stoker with an engine drive and a two-speed gear reduction, and from Fig. 2, a sectional elevation.

Coal is shoveled or fed directly from an overhead bunker into the stoker hopper, from which it passes through a firebrick, tile-lined hopper gate controlling the thickness of the fuel bed across the full width of the stoker. The

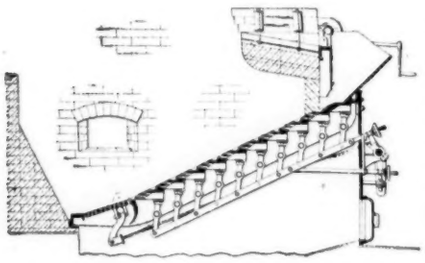


Fig. 2—Sectional elevation of stoker and setting

movement of the fuel across the grate is effected by the reciprocating action of the grate bars, which is regulated by the speed of the driving mechanism and adjustable as to length of stroke.

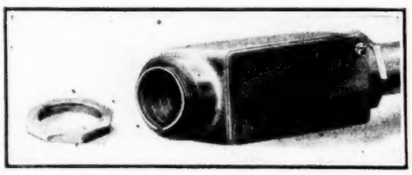
The fuel is burned by the progressive coking and distilling process. The slicing and cutting action of the reciprocating grate bars tends to keep the clinkers broken up and prevent their adhering to the grates.

The type of drive used is shown in Fig. 1 to consist of a vertical engine with a two-speed gear box from which an eccentric rocks the drive shaft extending across the front of the stoker. An alternate drive is a variable-speed motor with worm-gear reduction. Arms on the drive shaft reciprocate the grate bars. The grate of the stoker is made up in two sections. In either half alternate bars are attached to one arm and the other bars of the section to a second arm, one arm projecting downward from the shaft and the other upward, so that the movements of adjacent bars are in opposing directions and produce the shearing action previously mentioned.

From each rocker arm the reciprocating mechanism consists of a longitudinal rod to which are pinned a series of primary or operating levers with gear-sector attachment to the bottoms of the alternate bars. The stroke of the bars is adjusted by means of the handwheels at the ends of the longitudinal rods shown in the front view of the stoker, Fig. 1. The dump grate is operated separately by hand by the pull rods shown in the front and sectional views.

Erie Malleable Iron Co. "Kondu-Box"

With a view to simplifying and reducing the cost of conduit installations the threadless conduit fitting shown in the illustration has recently been de-



New type conduit fitting

veloped by the Erie Malleable Iron Co., Erie, Pa.

The new fitting, which is known as "Kondu-Box," has been so designed that every connection or outlet is essentially a union in itself, which feature eliminates the use of running threads or unions.

In place of the usual screw the end of the box is fitted with a split bushing and locknut which serves to hold the conduit in position. The bushing is case-hardened and is designed to give a parallel grip on the conduit by having a tapered thread for the locknut as well as a taper on the interior of the box in which it seats. A running ground is secured by means of ridges or ground rings on the interior of the bushings which are forced through the enamel on the conduit as the locknut is tightened. The bushing is made with a machined bead against which the conduit seats, which insures a smooth surface at the entrance to the pipe.

Additional advantages claimed for this type of box are the possibility of using light wall tubing in place of the regular weight conduit and the exchanging of fittings without disturbing the line. With this box one fitting may be replaced by another by simply unscrewing the locknut and slipping the bushing inside the box, after which the box may be removed from the line and the desired type substituted.

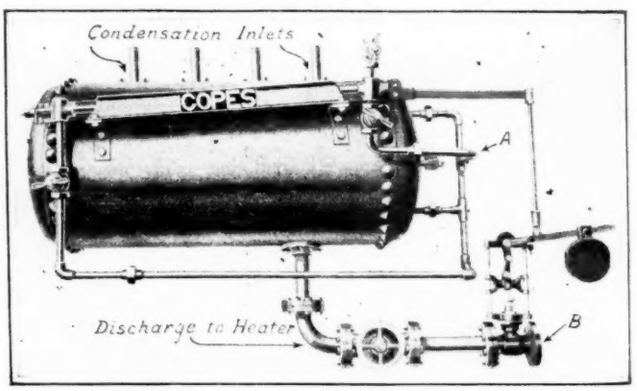
To the regular line of fittings there has been added a complete line of threadless couplings as well as adapters for use with standard steel knock-out boxes and adapter bushings, which permit the use of the new type of fittings on flexible conductor installations.

Copes Condensation Control

The illustration shows a condensation control brought out recently by the Northern Equipment Co., Erie, Pa. The principle of operation of the control is similar to that of the feedwater regulator manufactured by this company, in that the control valve is actuated by a thermostatic expansion tube, the essential difference being that the action of the condensation control is intermittent and regulates the discharge from the tank instead of the supply.

Referring to the illustration, the condensation from various points in the line is carried to a high-pressure tank through a number of inlets as shown, and from there is discharged to the heater. The regulator is connected to the tank at the highest water level desired.

In operation the tank fills with water until the steam that enters the expansion tube through the connection *A* is sealed off. This allows the expansion tube to fill with water at a lower temperature, which causes it to contract and open the valve. As the water in



Assembled view of condensation control

the tank recedes, steam is again admitted to the expansion tube, causing it to expand and close the valve. Then the cycle is repeated. The control valve *B*, which is of small area, is fitted with a special nickel-steel ball and seat.

Recent Publications

National Directory of Commodity Specifications—Classified and Alphabetical Lists and Brief Descriptions of Existing Commodity Specifications. Miscellaneous Publications No. 65, Superintendent of Documents, Government Printing Office, Washington. Cloth; 8x11 in. Price, $1.25.

This volume is the first attempt on the part of the Department of Commerce to collect and publish a classified list of existing commodity specifications in use by the federal government, in state and city governments, public utilities, technical societies and trade associations. The collection of the material for this directory has been in charge of A. S. McAllister, of the Bureau of Standards, assisted by F. R. Wadleigh, John Matthers, Jr., W. H. Rastall and the staffs of the Bureau of Standards and the Bureau of Foreign and Domestic Commerce. It is unusually well arranged, giving alphabetical lists of specifications in general use, by whom they were prepared and where copies can be obtained.

Rewinding Small Motors. By Daniel H. Braymer and A. C. Roe. Published by the McGraw-Hill Book Co., Inc., 370 7th Ave., New York City, 1925. Cloth; 9x6 in.; 247 pages; 210 illustrations. Price, $2.50.

In the literature on rewinding electrical machinery there has been a tendency to concentrate attention on the medium- and large-sized machines, and to neglect the fractional horsepower equipment. From point of size and total capacity this attitude toward the small machine may have been justified, but when the numbers of machines in use and the wide variety of windings used in them are considered, the small-sized machine merits more attention to its operation and maintenance than has been given by technical writers. This book is unique as a work on armature winding in that it is devoted entirely to the practical details of repair-shop practice with step-by-step procedure for rewinding all types and designs of fractional horsepower motors. The work is divided into two parts, one dealing with direct-current motors and the other with alternating-current motors.

The text begins with the time the job enters the shop and shows how to obtain a proper record of the machine. From this as a starting point the details of the work are followed through until the machine is again ready for service. Among the chapters on direct-current motors are those dealing with insulating the armature core; the loop winding; chorded split-loop winding; the split-loop winding; winding automobile starter and generator armatures; connecting up hand-wound armatures; and testing armatures while and after winding. Representative chapters in the section on alternating-current motors are: Testing and locating faults; insulating the core and winding; how to make up a skein winding; how a hand winding is put in the stator; connecting a skein-wound or hand-wound stator; rewinding small universal motors; rewinding small two- and three-phase motors; changing single-phase winding for two- or three-phase operation; and testing single-phase motors while and after winding.

The treatment is entirely from the practical viewpoint and the illustrations show how the various steps of the work are done. This book should be of valuable assistance to those who have to inspect, maintain and rewind small motors, and also find a wide field of usefulness in schools giving courses in industrial electricity.

The Marine Steam Engine. Fourteenth Edition. By Richard Sennett and Henry J. Oram. Published by Longmans, Green & Co., New York and London. Cloth; 6x9 in.; 466 pages; 414 illustrations. Price, $8.50.

That an engineering treatise can go through fourteen editions is indicative of its filling a well-defined need. This latest edition is somewhat more extended in its scope than were its predecessors, covering the latest developments in the marine field. The volume is intended to give the operating engineer a bird's-eye view of the several departments of power engineering and does not attempt to deal exhaustively with any single subject. For the oiler or young engineer going up for his license, the volume will come in handy.

A Safety Code for Elevators. American Society of Mechanical Engineers, 33 West 39th St., New York City, 1925. Paper; 5¼x7¾ in.; 6 illustrations; 10 tables. Price, 60c.

This safety code, which includes rules for construction, inspection, maintenance and operation of elevators, dumbwaiters and escalators, is sponsored by the United States Bureau of Standards, American Institute of Architects and the American Society of Mechanical Engineers. The code is now issued in its first revision and has been approved by the American Engineering Standards Committee as an American Standard. The first edition of this Code, prepared by the Subcommittee on Protection of Industrial Workers of the American Society of Mechanical Engineers, with the assistance of representatives of a number of interests including manufacturers, insurance carriers, regulatory bodies, and technical societies, was published in January, 1921. This Code was drawn up in view of the need for uniform regulation covering the hazards of elevator operation. It was widely circulated and has been used as the basis for several state and municipal codes. While the revised edition of the Code closely follows the first edition in form and requirements, there has been a rearrangement of some of the material in Parts I, II and III, making the order of presentation somewhat more logical. New material has been included in several places, notably under Definitions and the various sections on safeties, terminal stopping devices, and buffers. A system of key numbers has been added to indicate whether a rule should be made retroactive, and if so, how long a period after the adoption of the Code should be permitted to bring the equipment in question up to the Code requirements.

Technical Vocabulary. F. de Carvalho Henriques, Apartado 145, Lisboa, Portugal. Cloth; 5x7½ in. Price $1.50 plus 15c. postage.

This little book contains 1,500 terms with their Portuguese and French respective equivalents. These terms refer mainly to steam boilers, engines, tools and machine tools. To manufacturers and engineers who frequently encounter French and Portuguese mechanical terms that are not usually found in a regular dictionary of these languages, this book will prove of distinct worth.

Heating and Ventilating Guide. Prepared and published annually by the American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Size, 6½x9¼ in.; 264 pp. of technical data and information, 250 pp. of catalog data section and a section of information concerning the society, including the roll of membership. Price, $3.

This edition of the "Guide" is larger than any previous edition and contains more technical data and catalog material. The section on heating covers the calculation of heat losses from buildings and the design, testing and control of equipment for heating buildings. The section on ventilation discusses the effect of humidity, temperature, and air motion on comfort, and describes and discusses various schemes for the tempering of air and the ventilation of buildings. To those whose duties include the design or supervision of heating and ventilating equipment, the "Guide" should prove a useful reference work.

Coils and Magnet Wire.—By Charles R. Underhill. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1925. Cloth; 9x6 in.; 494 pages; 197 illustrations; 43 tables. Price, $4.

Magnet wire and coils may, at first thought, seem to be a relatively unimportant part of the subject when dealing with electrical equipment. But when the different classes of wire with their numerous shapes and insulations, the vast array of coil shapes and sizes for an almost unlimited number of purposes, methods of making the coils and their insulation, etc., are considered, it becomes apparent that the subject is a very broad one. It is from this broad general viewpoint that the author has approached the subject in this book, and he gives a practical treatise on coil winding, magnet wire, insulating materials and the details associated with the design, manufacture and operation of coils in general. Although the book is written from the designer's and manufacturer's angle, it is in general easily read and contains much that will be useful to the practical man. This is particularly true of the chapter that deals with forms of coils, insulating

varnishes, methods of treating and impregnating coils and armatures, coil winding and coil testing. The rather complicated mathematical treatment of the various factors that enter into coil design have been reduced to a relatively few formulas and calculated tables, thus simplifying the design to a considerable extent. Tables have been made liberal use of throughout the work to show the properties of wire and coils, and the usefulness of the wire tables has been extended by giving them in both English and metric units. Other tables give properties of varnish for bonding insulation, characteristics of varnishes for various uses in electrical equipment, baking schedules for armatures and coils, properties of varnishes used for dipping and impregnating.

A.S.T.M. Tentative Standards for 1925. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia. Size, 6x9 in. Cloth, $8; paper, $7.

The "Tentative Standards" which is issued annually by the American Society for Testing Materials, are the proposed standards which are printed for one or more years with a view to eliciting criticism, of which the committee concerned will take due notice before recommending final action toward the adoption of such tentative standards by formal action of the society. The "Standards" and "Tentative Standards" are recognized as authoritative in the field of engineering materials. The 1925 volume contains 193 standards on: Steel, ferro-alloys and wrought iron; non-ferrous metals; cement, lime, gypsum and clay product; preservative coatings; petroleum products and lubricants; road material; coal and coke; timber; waterproofing; insulating materials; shipping containers; rubber products; textile materials; slate; miscellaneous.

Electrical Measurements and Meter Testing in Power Stations. By E. S. Lincoln. Published by the Weston Electrical Instrument Corp., Newark, N. J., 1925. Bristolboard; 6x9 in.; 155 pages; 113 illustrations. Price, 50c.

One of the criticisms that have been made of power-plant operating engineers, is that they do not make the use they should of the meters with which they are provided. Not infrequently, owing to lack of proper knowledge on the use of meters and how to maintain them in operating conditions, they have been allowed to fall into disuse by those who should use them. It is with the object in mind of assisting the user of electrical instruments to obtain maximum service from them that this book has been published. Although published by a manufacturing company, the book is not a catalog in any sense of the word, but a treatise on how to use, check and care for electrical measuring instruments and their accessories. Particular attention is given to operating suggestions for the standardizing and electrical laboratories of public-utility companies. Throughout the work many illustrations are used showing how to construct and use test boards for checking meters. The treatment is sufficiently broad to be applicable to both large and small plants, and the operating engineer or electrical worker with a limited knowledge of meters will find many helpful suggestions in this book.

A.S.M.E. Power Test Codes. — Two more of the A.S.M.E. Power Test Codes have appeared in final pamphlet form, forming a part of the series of 1923, by which this first edition is designated.

The Test Code for Reciprocating Steam Driven Displacement Pumps, prepared by a committee of which R. D. Hall is chairman, has been in preparation for a long time and is the result of the best thought of a committee of very capable experts. The code gives detailed instructions for the testing of this type of machinery, together with a four-page table of data and results. Price 45c. to non-members and 40c. to members.

The Test Code for Condensing Apparatus, prepared by a committee of which George A. Orrok is chairman, discusses at considerable length the methods of testing condensers of various types and the methods of computing results. The table of data and results which must cover a variety of conditions, occupies eight pages of the code pamphlet. Price 55c. to non-members and 50c. to members.

Both of these codes, in common with those that have previously appeared, have been entirely rewritten by subcommittees of the Power Test Codes Committee of the Society. They are not simply revisions of the 1915 code, but have been prepared independently, without regard to the text and arrangement of the old code. Anyone who is interested in testing a pump or a condenser should of course procure copies of these pamphlets. In this connection, *testing* need not be confined to formal acceptance tests or investigations, but applies equally to the every-day determination of the effective performance of equipment. The codes give valuable information as to the precautions that must be taken in determining various important quantities in connection with the performance of the equipment to which they apply.

A Study of the Detroit Edison Company—An interesting and instructive picture of the growth and service of one of our large central-station companies is contained in a pamphlet just issued by the Bankers' Trust Co., of New York, under title, "A Study of The Detroit Edison Company." This company, into which have been merged, from time to time, a number of earlier utilities serving this important industrial center, has grown in capacity during the last twenty years from 6,000 kw. to over 500,000 kw., supplied principally by four large steam plants. This represents a present capital investment, including distribution systems, of over $134,000,000. Looking at this from another angle, the kilowatt-hour per capita has increased during this period from 54 to 886—an increase of over 1,500 per cent, although the population has scarcely quadrupled. This is a striking testimonial to the influence of electric power as a factor in American industry. Moreover, Detroit enjoys the distinction of having 99 per cent of its residences connected to the company's line. Hand in hand with this growth has been the steady increase in operating efficiency. In 1906 the average coal burned per kilowatt-hour output was 3.16 lb., corresponding to an over-all efficiency of 5 per cent; today this system is producing a kilowatt-hour on 1.42 lb. of coal with an over-all efficiency of 14.6 per cent.

Instructions for Care and Operation of Transformers. These instructions have just been issued by the Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio, and the price is 25 cents. Recommendations are given for both power and distribution transformers. The instructions cover such subjects as installation, drying-out methods, normal operation, sampling and testing oil, putting transformers into service, inspection, etc. Because a transformer is a piece of equipment that may run for years without giving any trouble, it is likely to be neglected unless a definite inspection and maintenance program is rigidly followed. This little booklet offers many valuable suggestions for such procedures.

The Department of Conservation and Development of the State of North Carolina, division of water resources, has recently issued a map showing the interconnected power systems of the Southeastern States. This map, which was prepared for the Southern Appalachian Power Conference, is quite complete, showing the location of all power lines, their voltages, the location and size of all power installations and the location and size of the small and isolated power plants. It may be purchased from the division of water resources, State of North Carolina, Chapel Hill, for $3 a copy. In larger quantities the rate is cheaper.

Prosperity Through Power Development. A Compilation from Papers Presented at the First World Power Conference Held at London, Eng., July, 1924, by Julius H. Barnes, Arthur T. Hadley, Herbert C. Hoover, Samuel Insull, Carl D. Jackson, Dugald C. Jackson, W. S. Lee, John W. Lieb, Fred R. Low, A. H. Markwart, W. S. Murray, J. P. Noonan and Guy E. Tripp. Abstracted and published by the National Electric Light Association, 29 West 39th St., New York City, 1925.

Asa Martines Mattice—An Appreciation—By Walter M. McFarland, assisted by other old friends. In his appreciation of Asa Martines Mattice, Walter M. McFarland has paid a graceful tribute to an old friend and put upon record the qualities and achievements of one who did real work when the age of engineering was in its making.

Condensed Catalogues of Mechanical Equipment with General Classified Directory and Professional Engineering Service Directory. Fifteenth annual volume, 1925-26. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Flexible binding; 8¾x11½ in. Price, $5.

Huge Interconnection Merger Forecast

The Eastern States Power Corp. has been formed under the laws of Maryland to include the Carlisle interests of New York and the Schoellkopf interests of Buffalo. Coming after the announcement recently of a financial tie-up between the Carlisle interests and the New England Power Co., which also took in hydro-electric properties of the International Paper Co. for organization of the Eastern States Power Corp. is considered significant from the standpoint of "superpower" developments under way in New York and New England. It directly forecasts the joining up of leading New York and New England power companies.

It was said yesterday that the Eastern States Power Corp. had been formed primarily for the purpose of acquiring and holding securities of public utility companies. The corporation also is empowered to finance and underwrite issues of securities, to act as fiscal agent and to deal generally in securities, particularly those of companies interested in the development of the electric light and power industry.

As a securities concern the new corporation is in position to purchase and hold the securities of companies in which the New York, New England and Buffalo electric power interests see possibilities of important consolidation. Companies already identified with this merger movement in New York and New England include the Power Corporation of New York, which the Carlisle interests control; the New England Power Co. and the Malcolm G. Chace interests, who are also large factors in the International Paper Co. The formation of the securities corporation, representing both the Carlisle and Schoellkopf interests, reveals that the Buffalo, Niagara & Eastern Power Corp., formed some time ago as the consolidated company embracing the Niagara Falls Power Co., Niagara, Lockport & Ontario Power Company, and the Buffalo General Electric Company, probably will be party to the big Eastern power grouping.

The Mohawk-Hudson Power Corp., representing the Adirondack Power & Light Corporation, Power Corporation of New York, and certain up-state Brady utilities, are expected to become identified with this grouping.

Niagara Falls Power Co.'s Extra Diversion Held Up

Pending a settlement of the whole question of the diversion of 500 sec.ft. of water from the New York Barge Canal, the amended license recently authorized for the Niagara Falls Power Co. will not be issued. An item intimating that this diversion had been granted, subject to certain restrictions, was published in *Power*, Oct. 27, page 667. So as to prevent waste of water that otherwise could be used legally to generate power at Niagara Falls, a temporary license has been submitted to the power company.

There has been some delay in providing for the complete utilization of the waters of Eighteen Mile Creek. Some changes in ownership have been undertaken, however, and it is believed the situation will have been adjusted so that permanent rights may be given the Niagara Falls Power Co. covering the additional 225 cu.ft. per second.

Tentative Program of the A. S. M. E. Annual Meeting, New York City, Nov. 30 to Dec. 4, 1925

Papers of Interest to Power Plant Field

Monday morning and afternoon —Council meeting; Local Section's Delegates Conference and luncheon; Meeting of Main Committee of Power Test Codes.

Monday evening—Open house.

Tuesday morning—"Gas Engines of the Maryland Plant of Bethlehem Steel Co.," by A. A. Raymond; "Internal-Combustion Engine Transmissions," by Hermann Lemp; "Oil Engines as a Drive for Pipe-Line Pumps," by F. Thilenius; "The Tension Ratio and Transmissive Power of Belts," by C. A. Norman. Public hearing on Power Test Codes on Steam Turbines.

Tuesday afternoon — "The Value of Higher Steam Pressures in the Industrial Plant," by William F. Ryan; "The Supply of Industrial Power," by W. H. Larkin, Jr.; Joint Session with the A. S. R. E., "Centrifugal Compression as Applied to Refrigeration," by W. H. Carrier; "The Heat Balance Method of Testing Centrifugal Compressors," by M. G. Robinson; Henry Robinson Towne Lecture on "Engineering and Economics," by Hon. Herbert Hoover.

Tuesday evening—Award of Honorable Membership to Hon. Herbert Hoover and Worcester R. Warner, past-president of the A. S. M. E., Presidential address and Reception.

Wednesday noon—Luncheon of Council and Student Branch Delegates.

Wednesday afternoon—Annual report of Council; Award of Charles T. Main Junior and Student Prizes; Report of A. S. M. E. Investigation for S. P. E. E. on Mechanical Engineering Education; Steam Tables Research; Education and Training for the Industries of Non-College Type, Committee on Education and Training for Industries.

Wednesday evening—Annual dinner at Hotel Astor.

Thursday morning — "Radiation in Boiler Furnaces," B. N. Broido; "Recent Developments at Colfax Station," by C. W. E. Clarke; "Steam Bleeding and Turbine Performance," by C. D. Zimmerman; "The Development of a Unit Pulverizer," by R. Sanford Riley and O. Craig.

Thursday afternoon — "Steel Castings for use in High-Pressure Steam Lines," by A. E. White; "The Quality of Bolts for Use in Power-Plant Construction," by W. P. Wood; "Furnace Refractories," by E. B. Powell; "Graphical Study of Journal Lubrication, Part 3," by H. A. S. Howarth; "Charts for Studying the Oil Film in Bearings," by G. B. Karelitz; "Tangential Vibration of Steam Turbine Buckets," by W. Campbell; Robert Henry Thurston Lecture on "Engineering and Science," by Dr. Zay Jeffries.

Thursday evening — National Defense Division.

Friday—Council meeting; Committee meetings, Excursions.

Tri-State Power Commission Named

New York, Pennsylvania and New Jersey To Study Transmission and Control of Interstate Electric Energy

A JOINT committee was announced on Oct. 25 by the Governors of New York, New Jersey and Pennsylvania to study the transmission and control of electric power in the three states and to report to the three Governors.

During the closing days of the New York State regular legislative session of 1925 a bill was introduced authorizing the Water Power Commission to negotiate from time to time with any state in the Union and any Canadian province for the purpose of regulating interstate or international transmission, sale or delivery of electric current. This bill was introduced at the request of the Governor of Pennsylvania, passed the Senate but failed of passage in the Assembly, it being held that there was sufficient law on the statute books to enable the appointment of representatives from New York State to study the subject should Pennsylvania and New Jersey assume the initiative.

At the request of the Governors of Pennsylvania and New Jersey, Governor Smith, on the nomination of the Public Service Commission, has appointed as members of a commission to study the question of interstate transmission, regulation and sale of electric current: William A. Prendergast, of New York City, chairman of the Public Service Commission; George R. Lunn, of Schenectady, member of the Public Service Commision, and Charles R. Vanneman, of Albany, chief engineer of the Public Service Commission.

New Jersey has appointed: Dr. Charles Browne, of Princeton, member of the Board of Public Utility Commissioners of New Jersey; Isaac Alpern of Perth Amboy, president of the Perth Amboy Trust Co., a director in other financial institutions and a well-known business man of New Jersey; Robert F. Ingle, of Beach Haven, former member of the State Board of Commerce and Navigation.

Pennsylvania has named: Philip P. Wells, Deputy Attorney General and chairman Pennsylvania Giant Power Board; Clyde L. King, secretary of the Commonwealth and member of Pennsylvania Giant Power Board; Morris L. Cooke, consulting engineer and director Pennsylvania Giant Power Survey.

In a memorandum announcing the appointments Governor Smith said:

"A new era has been reached in the generation and transmission of electric light, heat and power. Electrical energy is being carried from one state into another and plans have been developed for carrying this power long distances through several states. Light, heat and power companies are advertising the sale of their securities and pointing out the number of states which they serve with electrical energy. This energy, passing as it does from state to state, immediately enters interstate commerce and as such can be regulated only by the federal government through Congress.

"What is true of the transmission of power between states applies to the States of New York, Pennsylvania and New Jersey where power passes from one to the other, though as yet in comparatively small quantities. Plans, however, are being developed for the transmission of Giant Power from the coal mines of Pennsylvania and the water power of New York to the industries and householders of these states and to those of New Jersey.

"Irrespective of what other states may do, it is the desire of the Governors of the States of New York, Pennsylvania and New Jersey that some action be taken to control and regulate these companies so furnishing electricity, in order that they may be compelled to provide adequate service at reasonable rates. Unless such action is taken, the states will be absolutely helpless to do it themselves, and unless Congress takes such action, they will be unable to protect themselves. If Congress does take action, the states will have nothing to say as to how these companies shall be regulated and the prices they shall charge."

First Unit at Yonah Plant "Brought In"

Unit No. 1 of the Yonah plant of the Georgia Railway & Power Co. was placed in service on Oct. 11. This is the first of three 12,500-hp. units to be installed at this plant, the fourth hydro plant now in service in the chain that the company is building on the Tallulah and Tugalo Rivers.

Sesqui Exhibition Building Program Cut in Half

Mayor Kendricks of Philadelphia on Oct. 27 announced that the original plan of the Sesqui-Centennial International Exposition would be abandoned and a curtailed building program adopted that would guarantee the opening of the exposition on June 1, 1926. The declaration was made at a meeting of the Board of Directors and was accepted by its members unanimously.

At the meeting the Moyor in announcing his decision said, "It has been my hope that four large exhibition buildings would be built for our exhibitors, and I have proceeded in that hope. For two of these buildings contracts have been signed, and they are now in the course of construction.

Ernest T. Trigg, chairman of the executive committee of the Sesqui and vice-president of the Sesqui-Centennial Exhibition Association, resigned from both positions on Oct. 28. At the same time Colonel David C. Collier, director general of the exposition indicated that he, too, intended to quit. Capt. Asher Carter, director of foreign exhibits, now abroad, is to be recalled it is stated. Confusion over the status of concessions is adding to the chaos evidently reigning at Sesqui headquarters.

New Hydro Plant for British Columbia

A large hydro-electric power plant is about to be constructed approximately 135 miles north of the City of Vancouver at Seton Lake. Within the next five years it is planned to spend $13,000,000 in the development of the first unit. Sixty thousand horsepower will be available from this new installation. Additional units may be installed later. Consul General Ernest L. Harris, Vancouver, in *Commerce Reports.*

Arizona Applies for Hydro Project on Colorado River

The Board of Directors of State Institutions for Arizona has applied to the Federal Power Commission for a preliminary permit for a development on the Colorado River at the bridge canyon site in Mohave County, Ariz. It is proposed to erect a rock-fill or concrete dam, to be so constructed as to make possible an ultimate height of 1,000 ft. Such a dam would develop 1,000,000 hp. it is estimated. The purpose of the improvement is to impound water for irrigation, to reduce flood danger, to provide power for pumping and other purposes and for marketing, and to provide water free from silt.

Fred T. Colter, of Phœnix, Ariz., on behalf of the State of Arizona, has asked for a preliminary permit covering a storage dam in Glenn Canyon and a diversion dam at Bridge Canyon. No explanation is made in the application as to the conflict with the application filed by the state for rights at Bridge Canyon only.

Girand's Diamond Creek License Again Deferred

All development of the water resources of the Colorado River and its tributaries, including the Gila and every other stream in the Basin, is to be suspended until the seven states concerned can agree. In the meantime James B. Girand, whose application precipitated this decision, has the encouragement of knowing that his right will be the first granted whenever the agreement between the states is reached.

The determination to take this action, it is presumed, took place at a Cabinet meeting on Oct. 27. On the following day the policy was embodied in a resolution of the Federal Power Commission, which is composed of the Secretaries of War, Interior and Agriculture. It seems to be the decision of the President and his advisors to let the states of the Basin understand unmistakably that they must reach some agreement among themselves before any development will be allowed to proceed throughout the vast territory drained by the Colorado.

Just at this time the decision is regarded by the opponents of the Girand license as a complete victory, but it is anticipated in official quarters that this action will stimulate the forces of attrition, which apparently must be applied to secure the discharge of the responsibility of all the states to one another.

Two New Hydro Plants for California

Plans of the Snow Mountain Water & Power Co. to erect, at a cost of approximately $3,200,000, two new hydro-electric power plants, one in Coyote Valley, in Mendocino County, and the other at Scott's Dam, in Lake County, with a total capacity of 43,226 hp., were revealed when the company applied to the State Department of Public Works for a permit to take 400 cu.ft. of water a second from the South Fork of the Eel River for the generation of power at three plants. The company, which serves Potter Valley and Ukiah, now has a plant on Gold Creek, a tributary of the Russian River. After passing through this power house and the two proposed plants, the water applied for will be emptied into the Russian River. The proposed plants are said to be part of a seven-million dollar program.

Power Show To Feature Economy in Fuel

The Fourth National Exposition of Power and Mechanical Engineering will open at 2 p.m. on Monday, Nov. 30, at the Grand Central Palace, New York City. It will extend through the week, ending Dec. 5, opening each day at noon.

The basic purpose of the Exposition is to bring together showings of manufacturers of power and mechanical equipment so that engineers and industrial executives may have an opportunity for comparative study of the outstanding developments in the field.

The decreased use of coal per ton of freight hauled on the railroads and the increased thermal efficiencies of the central power stations furnish two examples of the manner in which modern engineering is keeping step with the increased demand for greater economy in the use of fuel. The constantly turbulent condition of the coal industry furnishes incentive to all manufacturers who use power and heat to devote increasing attention to better economies in their power plants. In assisting to secure these economies the Power Show fulfills an important function in that it brings together all types of equipment under one roof, with competent interpreters of the importance of each device in attendance.

Devices to increase the effectiveness and economy of combustion will be presented at the Show in distinguished array. Air preheaters, pulverized-fuel equipment of all types, stokers, water-cooled boiler furnace walls, soot blowers and draft apparatus will be shown. One of the features of this group of exhibits will be the showings of recent developments in the more economical use of pulverized fuel. This will include new designs of boiler furnaces, several new types of burners for pulverized fuel and the latest achievements in crushing and drying coal.

The addition of a comprehensive list of heating and ventilating equipment is an important factor in the broadening scope of the Power Show, for the heating and ventilating problem in a factory or an industry is closely allied to the power problem and advantages in each are applicable to the other.

Muscle Shoals Commission Receives Offers from Utility and Chemical Companies

Alabama Power and Union Carbide Companies Offer Plans—The American Cyanamide Co. May Have Suggestion

A PLAN WHEREBY a portion of the power at Muscle Shoals could be used for fertilizer manufacture and the remainder distributed for public utility use in a number of Southern states has been laid before the Muscle Shoals Commission by the Alabama Power Co. A communication also has been submitted to the Commission by the Union Carbide Co. In accordance with its established policy the Commission does not make public the communications which it receives, but it is understood that the Carbide company suggests that some officer of the government be authorized to make contracts for private operation, to be submitted to congress for final approval. The Carbide company is understood to favor the leasing of the plant on a fifty year basis. It is further asserted that the company proposes that Congress indicate a part of the power which may be used at cost for the manufacture of fertilizer, the remainder to be available for electrochemical manufacture in the vicinity of Muscle Shoals and for distribution. The Carbide plan is understood to provide for the initiation of fertilizer manufacture with provision that production be increased as the market demands. The additional thought is expressed that provision could be made for the sale of fertilizer to the farmer at a price not more than eight per cent of the cost of production, and that the power plant should be charged with four per cent interest on the cost of the dam less an allowance for navigation.

As this is written, the American Cyanamide Co. is preparing a communication which it is planned to submit to the Commission late in the week.

The communication from the Alabama Power Co. is in the form of a letter from Thomas W. Martin, its president, in which he states that should his company embark on the plan there would be associated with it persons and companies "engaged in the production of fertilizer and fertilizer ingredients and also others who have the right to use chemical processes adaptable to these plants for fertilizer production," and a group of additional public utility companies engaged, under regulation, in producing and distributing power in the South.

"During the period of the development of fertilizer production," says the power company communication to the Commission, "and doubtless for sometime after the manufacture of fertilizer is begun on a commercial scale, there will be much surplus power from the government power plants which can be absorbed in public service for domestic and industrial use by consumers through existing interconnected transmission systems, and through other transmission lines now under construction or proposed to be constructed in Mississippi, Western Tennessee, portions of Louisiana and Northern Florida."

This arrangement would make possible the commercial utilization of much secondary power at Dam Number 2, insure a maximum use of its power facilities at the most economical cost of production for all purposes, and permit the interchange of power so that an excess supply in one section would become available immediately for use at other points throughout the interconnected system and would enable the government to realize the best return for power not required for national defense and fertilizer production. The power companies of the Southeastern States are prepared to assist materially in coordinating the public facilities at Muscle Shoals with power facilities elsewhere in order to provide the maximum output of power from the facilities of the government for national defense, for the production of fertilizer or other useful products and the distribution of power.

Los Angeles Applies for Colorado River Power

Applications have been filed by the Los Angeles Municipal Bureau of Power and Light with the California and Arizona water commissions and the Federal Power Commission for permission to divert the waters of the Colorado River near the town of Parker, Ariz. In case of favorable action by the various commissions it is planned to construct a dam at this site which would make available approximately 1,500,000 acre-feet of water for the City of Los Angeles and would develop at least 100,000 hp. of electrical energy, in addition to acting as a secondary water control project in conjunction with the proposed Boulder Canyon dam.

$50,000,000 Project for The Ozarks

A waterpower project to develop 183,000,000 kw.-hr. of primary power and 150,000,000 kw.-hr. of secondary power is about to be developed in the heart of the Ozark Mountains of Missouri under the supervision of the Guy Huston Co., of New York City, it has just become known. The plans call for the construction of a huge artificial lake in the mountains to regulate the flow of water, at an ultimate cost for the whole project of about $50,000,000.

The lake will be formed by damming up the Osage River at Bagnell, Mo., where the hills form a narrow neck. This site is almost equidistant between St. Louis and Kansas City, Mo., so that a ready market is anticipated. It is expected that when the project is completed, the power generated will replace that now generated by steam plants for Kansas City, Mo., and Kansas City, Kan., leaving these former units to serve for emergencies.

Government Needs Hydro Engineers

The United States Civil Service Commission recently announced open competitive examinations for a hydro-electric engineer, at an entrance salary of $3,900, an associate hydro-electric engineer at $3,300 and an assistant hydro-electric engineer at $2,400. Applications for these positions will close on Nov. 24. The position is in the Engineer Department at Large, Chattanooga, Tenn.

Southern Power Co. To Build New Steam Plant

Officials of the Southern Power Co. announced recently, the award to the G. E. Co. of a contract for two 50,000-hp. steam turbines for a steam-electric plant to be built, in accordance with a recent announcement of the Southern Power Co., to safeguard that company against recurrence of the drought of this year. The new plant will be rated at 100,000 hp., instead of 80,000 hp., as was originally planned, and will therefore be twice as large as the one at Mount Holly. The site of the new plant has not yet been announced, but it is understood that it will be on the Catawba River.

Bituminous Coal Production Nearing High Record Point

Total bituminous production during the week ended Oct. 17, including lignite and coal coked at the mines, is estimated at 11,767,000 net tons, an increase of less than one per cent over that of the week preceding. Responding to stimulated demand, soft-coal output during the month of September was maintained at a daily rate of about 1,843,000 tons. The rate established so far during the two full weeks in October is about 1,950,000 tons per day —a gain of almost 6 per cent. The current rate of output approaches the high record point touched in recent years.

Production of anthracite during the week ended Oct. 17 is estimated at 17,000 net tons, an increase of 4,000 tons over that of the preceding week. Total output since Jan., 1925, is now 61,710,000 tons—14.6 per cent less than that during the corresponding period in 1924.

Link-Belt Co. Celebrates Fiftieth Anniversary

Fifty years have passed since the incorporation of the Ewart Manufacturing Co., the forerunner of the present Link-Belt Co., in 1875. In commemoration of the fiftieth anniversary, the latter company has published an attractive book entitled "Link-Belt 1875-1925."

In this book it is mentioned that the patent of William Dana Ewart, a young implement dealer, from Belle Plaine, Iowa, for the detachable link chain, was dated Sept. 1, 1874. Mr. Ewart first started to build a self-binding harvester, but he realized the great need in such a machine for a detachable chain drive that could be repaired in the field; and he worked out the idea of a chain drive, the links of which could easily be replaced by the farmer.

Late in 1874, when Mr. Ewart came to Chicago with a view to arousing some interest in his "detachable link chain," he succeeded in interesting John C. Coonley, a lawyer who was then president of the Chicago Malleable Iron Co. As a result a company was duly incorporated in 1875, under the name of the Ewart Manufacturing Co., for manufacturing detachable link chain. In 1876 these chains were exhibited at the Philadelphia Centennial.

New uses for the invention developed rapidly, and in 1880 the Link-Belt Machinery Co. was incorporated. In 1888 the Link-Belt Engineering Co., was formed, with a plant in Philadelphia. In 1906 a consolidation of the three interests took place, and Charles Piez was elected president.

Mr. Piez is chairman of the board of directors, and Alfred Kauffmann, formerly vice-president in charge of the two plants in Indianapolis, is president of the company.

Obituary

George E. Crisp, treasurer of The Superheater Co., died after a prolonged illness at his home in East Orange, N. J., on Oct. 11. Mr. Crisp was born Feb. 16, 1870, and received his education at Albert Memorial College, London, England. He traveled extensively in the United States and Canada, and was identified with the early development of the Canadian Northwest. Mr. Crisp was associated with The Superheater Co. for ten years. He was well known in the power-equipment and railway-supply field.

George M. Basford, railroad publicist and engineer, head of the G. M. Basford Company and a member of the Main Committee of the Power Test Codes of the A.S.M.E., dropped dead in the Jerome Ave. subway station in New York City on the evening of Oct. 26. Mr. Basford was born in Boston in 1865 where he attended the public schools. He was graduated from the Massachusetts Institute of Technology in 1889 after which he entered the Charleston shops of the Boston & Maine Railroad. For many years he was identified with the principal railroads and signal companies of the country and was for several years an editor on various railway magazines. In 1916 he organized the G. M. Basford Co. to handle technical advertising. At about this time he was also made president of the newly organized Locomotive Feedwater Heater Co., and was its head until it was taken over by the Superheater Company. Mr. Basford was deeply interested in the human element as contrasted to materials and methods. He was always striving to strengthen and improve the various associations and organizations with which he was identified. Beside the A.S.M.E., he was a member of the Railroad Signal Association, the Engineers' Club and many railroad associations and clubs. He is survived by his widow and two daughters.

Personal Mention

H. P. Childs, formerly with the Heine Boiler Co., is now connected with the Servel Corp., 51 East 42nd St., New York City.

Edward L. Champion, formerly with the City of Pasadena, is now connected with the condenser department of The Ingersoll-Rand Co., 11 Broadway, New York City.

W. D. Drysdale has been relieved of his duties as plant engineer of the Trenton Channel Plant and has been appointed assistant engineer of power plants of the Detroit Edison Co. reporting directly to the chief and chief assistant engineer of power plants.

C. J. Priebe, formerly connected with the editorial and advertising staffs of *American Machinist*, is now New York representative of the Ross Heater & Manufacturing Co., Inc., of Buffalo, and has offices at 2 Rector St., New York City.

Ralph Briscoe, formerly assistant plant engineer of the Trenton Channel Plant of the Detroit Edison Co., has been appointed plant engineer and will be responsible for the operation and maintenance of all plant equipment.

David Moffat Myers, consulting engineer, 1 Madison Ave., New York City, who announced the establishment of a new office on Sept. 1, 1925, as consultant on industrial power-plant design and operation, now announces that he has associated with him **William Allen Shoudy, Percy H. Thomas** and **Osborn Monnett.**

Society Affairs

The Connecticut Section of the A.I.E.E. will hold its Nov. 9 meeting in the auditorium of the Hartford Electric Light Co., at 266 Pearl St., Hartford. F. W. Peek, Jr., of the G. E. Co., Pittsfield, will speak on "Lightning and High Voltage Phenomena."

The New York Section of the A.M.R.E. held its seventh meeting of the season on Oct. 14 at the Machinery Club, in conjunction with the New York Chapter of the National Association of Practical Refrigerating Engineers. The subject was "Synthetic Ammonia."

The Society of Naval Architects and Marine Engineers will have two papers of interest to *Power* readers on its general meeting program, which will be held on Nov. 12 and 13 at the Engineering Building, New York City. The papers are: "Torsional Vibration in the Diesel Engine," by Frank M. Lewis and "The Double Acting, Two-Cycle Oil Engine," by Olav E. Jorgensen.

The Philadelphia Section of the Association of Iron & Steel Electrical Engineers will have as the subject for its Nov. 7 meeting, which will be held at the Philadelphia Engineers' Club, 1317 Spruce St., Philadelphia, "Lightning Arrester Protection on 13,200-volt and 2,400-volt Distribution Lines," by E. D. Panzer and A. R. Wood, Philadelphia Electric Co., and "Design and Research in Lightning Protection," by H. M. Towne, G. E. Co.

The Washington Section of the A.S.M.E. will hold its Nov. 11 meeting at the Cosmos Club. E. W. McCullough, U. S. Chamber of Commerce, will speak on "Standardization and Simplification and Their Relation to the Engineer."

Business Notes

The Crocker-Wheeler Co., Ampere, N. J., announces a change in its company name, effective Nov. 1. The new name will be Crocker-Wheeler Electric Manufacturing Company.

The Bundy Steam Trap Co., Nashua, N. H., announces that it has appointed the Reed Engineering & Supply Co., 12 Amherst St., Worcester, Mass., and the Hauer Power Equipment Co., Union Trust Bldg., Cincinnati, Ohio, as its exclusive agents in their respective territories.

The George J. Hagen Co., furnace and combustion engineers, Chamber of Commerce Bldg., Pittsburgh, Pa., announces the appointment of J. Sparer, 2 Rector St., New York City, as district representative for Hagen steam-jet ash conveyors.

The Westinghouse Electric International Company announces new appointments: C. V. Allen, formerly manager of the company in Mexico, has been elected assistant to the treasurer, H. A. Carmichael, with headquarters in New York City; Clayton T. Rogers, sales manager for the Mexican branch, has been named acting manager, succeeding Mr. Allen.

The Air Preheater Corp., 25 Broadway, New York City, manufacturer of the Ljungstrom Air Preheater, is a consolidation of the James Howden & Company of America, Inc., and the Ljungstrom interests of Stockholm, Sweden. The newly formed corporation takes over all Ljungstrom patent rights of the preheater, together with the shops of the James Howden & Company of America, Inc., at Wellsville, N. Y. B. G. Brolinson has been elected president of the new corporation and W. L. Batt, president of the S. K. F. Industries, is chairman of the board of directors. The executive offices of the corporation are at 26 Broadway.

Trade Catalogs

Pyrometers, Recording—The Brown Instrument Co., Wayne and Windrim Aves., Philadelphia, Pa. The new designs of recorders are shown in illustrations and are fully described in a catalog recently received.

Pumps—The DeLaval Steam Turbine Co., Trenton, N. J. Centrifugal pumps, single-stage and multistage, is the subject of a 72-page catalog recently issued by this company. A large number of photos of installations showing the application and arrangements of these pumps as well as useful tables of information, are included.

Stoker, Taylor—The American Engineering Co., Aramingo and Cumberland Sts., Philadelphia, Pa. A new and attractive catalog describing the Taylor Stoker has just been issued. It contains considerable new matter, including a section on the use of preheated air, for which a new type of stoker has been developed. It also contains a description of the distributing ram system, which makes it possible to vary the volume of the retort to suit the burning characteristics of different kinds of coal. Photos of recent installations of this type of stoker in important power plants are included.

Furnaces, Fin-Type, Water Cooled—The Combustion Engineering Corp., 43 Broad St., New York City. The new catalog "FF-1" issued by this company, describes in detail the fin-tube water-cooled wall as applied to boiler furnaces. Large illustrations show the application of this type of furnace to the different types of boilers and methods of firing, including chain-grate and underfeed stokers, pulverized coal and oil. Two types of wall construction are illustrated, the type that has been used in a number of installations in which the tile and insulation are tied in with the casing, and the more recently developed type of construction in which the wall is suspended from the tubes.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

American Institute of Chemical Engineers—Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Sinton Hotel, Cincinnati, Ohio, Dec. 2-5.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12, 1926.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Marine Exposition. Peter A. Sensenrg, 15 Park Row, New York City. Exposition to be held in the 212th Anti-Aircraft Armory, 62nd St. and Columbus Ave., New York City, Nov. 9-14.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 4.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

American Society of Safety Engineers. G. S. Wood, 29 West 39th St., New York City. Meeting at New York City, Nov. 18.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Hotel Chelsea, Atlantic City, Nov. 23-25.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers. Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Convention at the Engineering Building, 29 West 39th St., New York City, Nov. 12-13.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Oct. 26 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	1.88
Clearfield	Boston	1.75@ 2.10
Somerset	Boston	1.85@ 2.20
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.05@ 2.25
Pittsburgh gas slack	Pittsburgh	1.35@ 1.50
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.20@ 1.50
S. E. Ky.	Louisville	1.40@ 1.65
Big Seam	Birmingham	1.60@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.60

FUEL OIL

New York—Oct. 29, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal., 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 13, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32@36 deg., gas oil, 4.5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Oct. 13, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Oct. 24 f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Oct. 21, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.70@$1.76; 13@19 deg., $1.60@ $1.66 per bbl.

Boston—Oct. 26, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¾c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Oct. 27, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Oct. 27, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.10 per bbl.; 30@32 deg., $1.25.

New Plant Construction

Ark., Almyra—City is having preliminary plans prepared for the construction of waterworks and distribution systems including pumping plant, tank on tower, mains, etc. A. M. Lund, 528 Southern Trust Bldg., Little Rock, is engineer.

Ala., Faunsdale—Watkins Banking Co., S. Stollerwercke, Cashier, wants data and prices on machinery for small ice plants.

Ark., Blytheville—Chicago Mill & Lumber Co., 500 North Dearborn St., Chicago, Ill., plans the construction of a lumber mill including power plant, etc., here, to replace fire loss. Estimated cost $400,000. Work will be done by owners forces.

Calif., Long Beach—Southern California Edison Co., 306 West 3rd St., Los Angeles, awarded contract for the construction of a switch station and generator plant here to Stone & Webster, Byrne Bldg., Los Angeles. $750,000.

Calif., San Leandro—St. Marys College, Broadway and Hawthorne St., is having plans prepared for the construction of a group of buildings including power plant, etc. Estimated cost $3,000,000. J. J. Donovan, Trapscott Bldg., Oakland, is architect.

Calif., Soldiers Home (Sawtelle P. O.)—National Home for Disabled Volunteer Soldiers, Pacific Branch, G. T. Baggott, Treas., will soon receive bids for addition to power plant including a 400 hp. water tube boiler, 200,000 p.p.h. open hot water heater, 12 in. high pressure steam heater, etc.

Calif., Watsonville—City is having plans prepared for the construction of a sewage pumping and screen plant. H. B. Kitchen, is city engineer.

Fla., Boca Raton—Mizner Development Corp., plans the construction of a 50,000 ton annual capacity ice and cold storage plant.

Fla., Hollywood — Hollywood Electric Light & Water Co., J. W. Young, Gen. Mgr., plans the construction of a 100 ton ice and cold storage plant. Private plans.

Fla., Live Oak—Standard Lumber Co., Live Oak, is in the market for a 400 kw., 250v., d.c. generator connected to engine.

Fla., Palm Beach—Florida East Coast Hotel Co., c/o Schultze & Weaver, 17 East 49th St., New York, N. Y., Archts. and Engrs., will receive bids until Nov. 9 for the construction of a 6 story hotel here. Estimated cost $3,000,000.

Fla., Webster—P. A. Thompson, Mayor, will receive bids until Nov. 5 for the construction of a pump house including two 500 g.p.m. pumps, 60,000 tank on 75 ft. tower, etc. J. B. McCrary Engineering Corp., Citizens & Savings Bank Bldg., Atlanta, Ga., is engineer.

Ill., Chicago—Cass Street Building Corp., c/o Oldefest & Williams, 605 North Michigan Ave., Archts., is having plans prepared for the construction of a 15 story hotel including vapor heating system, freight and passenger elevators at 644 Cass Ave. Estimated cost $800,000.

Ill., Chicago—McCormick Estate, J. E. Stone, Agt., 30 North LaSalle St., awarded general contract for the construction of a 6 story store building at East Lake St. and North Michigan Ave., to Dahl-Stedman Co., 11 South LaSalle St. Estimated cost $1,000,000.

Ill., Chicago—A. W. Swayne, 400 North Michigan Ave., awarded general contract for the construction of a 17 story apartment at 59th St. and Stony Island Ave., to Avery Brundage Co., 110 South Dearborn St. Estimated cost $2,000,000. Owner and P. F. Olsen, 72 Cass St., Archt., taking bids until about Nov. 10 for heating, electric, elevators, etc.

Ill., DeKalb — Rochelle Canneries, Rochelle will soon receive bids for the construction of a group of buildings including a power plant on Lincoln Highway here. Boilers, electric motors, deep well and boiler pumps, etc. will be required.

Ill., Great Lakes—Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 11 for ash handling system for Naval Training Station here.

Ill., Lockport — City will receive bids about Dec. 1 for the construction of a well house including pumping equipment. Maury & Gordon, 304 South Dearborn St., Chicago, are engineers.

Ill., Warsaw—City will receive bids about Dec. 1 for the construction of a 250 g.p.m. water purification plant including motor driven pumping equipment. Estimated cost $20,000. Edward Flad Co., 1312 Chemical Bldg., St. Louis, is engineer.

Md., Baltimore—J. E. Sperry, Calvert Bldg., Archt., will receive bids until Nov. 10 for the construction of an 8 story dispensary for John Hopkins Hospital, Monument and Wolfe Sts. Estimated cost $1,000,000. H. F. Doeleman, 507 North Charles St., is engineer.

Mass., Milford—Milford Electric Light & Power Co., 241 Main St., awarded contract for the construction of addition to plant to Dillon Bros., 211 Main St. Estimated cost $40,000.

Mass., Quincy (Boston P. O.) — Norfolk Woodworking Co., Braintree, will build a lumber mill including boiler house, dry kiln, etc. on Hancock St., here, by day labor. Estimated cost $70,000. S. S. Joslin, 339 Newbury St., Boston, Archt.

Mich., Detroit—Malcolmson & Higginsbotham, 1217 Griswold St., Archts., will receive bids until Nov. 9 for the construction of a 3 story school building including power house, at Six Mile Road for University of Detroit, 630 East Jefferson Ave.

Mich., Detroit—F. Wardell, Dewey and Hamilton Aves., is having plans prepared for the construction of a 12 story hotel including steam heating system at Kirby and Woodward Aves. Estimated cost $2,500,000. Weston & Ellington, 1507 Stroh Bldg., are architects.

Mich., Grand Rapids—W. G. Yates, is receiving bids for the construction of two water power plants on Thornapple River, 4,500 kw. total capacity. Burd, Giffels & Hamilton, 425 Powers Bldg., are engineers.

Miss., Magee—City plans to expend $40,000 for the construction of waterworks and distribution systems, including motor driven pumping equipment. Swanson-McGraw, Inc., Balter Bldg., New Orleans, La., are engineers.

Miss., Meridian—Tutt Ice Co., J. B. Tutt, Pres., plans the construction of a new ice manufacturing plant at 7th and Thirty-sixth Aves. Estimated cost $75,000.

Miss., Vicksburg—Lamb-Gray Mfg. Co., Box 675, wants data and prices on one 450 to 500 kw. direct connected generator.

Mo., Marviell—Arkansas-Missouri Cotton Co., Inc., E. C. Cox, Pres., is in the market for a pump to be driven from line shaft, 250 to 300 g.p.h. capacity.

Mo., St. Louis—Bd. of Public Service, 208 City Hall, will soon receive bids for the construction of a power plant at Clark Ave. and 12th St. Estimated cost $1,000,000. Study & Farrar, Arcade Bldg., are architects.

Mo., St. Louis—Polar Wave Ice & Fuel Co., 3638 Olive St., will soon award contract for the construction of an ice plant, 150 ton daily capacity and 10,000 ton storage space at Shaw Ave. and Missouri-Pacific tracks. Estimated cost $100,000. H. G. Clymer, Wainwright Bldg., is architect.

Mo., Senath—City will receive bids about Dec. 1 for the construction of waterworks and distribution systems including pumphouse, two deep wells, two deep well turbines, 75,000 gal. tank on tower, etc. Edward Flad & Co., 1312 Chemical Bldg., St. Louis, are engineers.

Neb., Grand Island—City received low bid for the construction of a power plant from E. Rokahr & Sons, Grand Island, $49,150. C. L. Pillsbury, is engineer.

Neb., Hastings—Swift & Co., 28th and O. Sts., Omaha, is having plans prepared for the construction of a cold storage and produce plant here. Estimated cost $150,000.

N. J., Trenton — St. Francis Hospital, Chambers and Hamilton Sts., awarded general contract for the construction of a boiler house to T. M. Day & Son, Day Bldg. cost $37,997. Total estimated cost $81,897.

N. C., Hendersonville—J. J. Henson, St., Petersburg, Fla., has purchased 455 acres on Stony Mountain, four miles from here, and plans the construction of a 2,000 room hotel on the summit also to develop remainder into villa sites involving waterworks, lighting system, etc.

N. C., China Grove—A. A. Hurley, Mayor, will receive bids until Nov. 10 for the construction of sewer and waterworks systems including deep well pump house, 75 g.p.m. motor driven deep well pump, 75,000 gal. tank on 100 ft. tower, etc. J. B. McCrary Engineering Corp., Citizens and Savings Bank Bldg., Atlanta, Ga., is engineer.

N. C., Oteen—U. S. Veterans Bureau, Washington, D. C. will receive bids until Nov. 17 for the construction of a refrigerating plant at U. S. Veterans Hospital here.

N. Y., New York—Jatison Construction Co. Inc., c/o Schwartz & Gross, 347 Madison Ave., will build a 14 story apartment at Park Ave. and 90th St. by day labor.

Okla., Buffalo—D. J. Kendall, plans the construction of a 30 ton ice plant to replace fire loss. Estimated cost $25,000 to $40,000. Private plans. $25,000 worth of equipment including a 120 hp. engine and generator, etc. will be installed.

Ore., Portland — Clark-Wilson Lumber Co., Linnton, is receiving bids for the construction of an 8 or 10 story hotel at Broadway and Madison St., here. Estimated cost $500,000. Architect and engineer not announced.

Pa., Germantown (Phila. P. O.)—Lincoln Drive Apartments, c/o Sugarman & Berger, 345 Madison Ave., New York, N. Y., awarded contract for the construction of a 14 story apartment here to Longacre Engineering & Construction Co., Inc., 345 Madison., New York, N. Y. Estimated cost $2,750,000.

S. D., Sioux Falls—City plans an election to vote $300,000 for an electric light plant.

Tex., Harlingen—Valley Electric & Ice Co., awarded contract for the construction of an ice plant to Sumner-Sollitt Co., c/o National Bank of Commerce, San Antonio. $40,000.

Tex., LaFeria—Valley Electric & Ice Co., San Benito, has acquired the plant of LaFeria Light & Ice Co., and plans the installation of an engine, generators, additional ice machine equipment, etc. in plant here. Estimated cost $25,000. Company engineers in charge.

Tex., Nederland—East Texas Electric Co., plans the construction of an electric light plant and 15 ton ice plant. Estimated cost $25,000. Company engineers in charge.

Tex., Sweetwater—Sweetwater Ice & Cold Storage Co. and West Texas Electric Co. Sweetwater, plans to expend $250,000 for improvements to electric and ice plant, capacity of ice plant to be doubled. Company will also purchase the Snyder Electric & Ice plant and plans the installation of additional equipment including engine, generators, etc.

Tex., Tahoka—City voted $60,000 bonds for improvements to waterworks including pumping equipment, mains, etc.

Tex., Victoria—Victoria Electric & Ice Co., W. E. Dickerson and S. M. Udden, Frost National Bank Bldg., San Antonio, is having revised plans prepared for the construction of an ice plant here. Estimated cost $30,000. J. M. Marriott, Frost National Bank Bldg., San Antonio, is engineer. Former bids rejected.

Wash., Seattle—Fifth Avenue Building Co., Metropolitan Bldg., awarded contract for the construction of an 8 story office building at 5th and Union Sts. to Tuefel & Carlson, Metropolitan Bldg. Estimated cost $1,500,000.

Wis., Kilbourn — Co-operative Creamery Co., B. Landt, Mgr., awarded contract for the construction of a 2 story creamery to Appleton Construction Co., I.O.O.F. Bldg., Appleton. Estimated cost $40,000. Owner is in the market dairy and refrigeration machinery.

Wis., White Fish Bay—G. H. Gottschalk Co., 111 West Washington St., Chicago, Ill., plans the construction of a hotel at Lake Drive here. Estimated cost $2,000,000. Architect not selected.

Man., Winnipeg — Hydro Electric System, Princess St., will receive bids until Nov. 9 for 2 units horizontal shaft turbines and governors. Estimated cost $125,000.